Ceele

Discussion paper

Criteria used for the selection of electrification projects in rural areas

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CONTENTS

1. Introduction

This document will attempt to highlight some of the important issues in the selection and prioritisation of settlements in rural areas for electrification, examining the processes followed and the criteria used to select electrification projects by the national utility, Eskom. Therefore, the focus will be on the national household grid electrification programme and will exclude off-grid, schools and clinics, and farmworker electrification. It is expected, however, that these important areas will be included in future project investigations concerning the selection criteria and policies for electrification.

The document has been structured in a way which will, it is hoped, stimulate debate and discussion. First, as selection of settlements for electrification falls within the ambit of electrification planning, the appropriate parts of Eskom's planning process will be outlined. At different stages in the planning process different selection and prioritisation criteria are used to include or exclude settlements or areas for electrification; these criteria will be discussed, as well as the extent to which these criteria are adhered to. Following this, the key issues for discussion and areas for further investigation will be highlighted.

2. The electrification planning context

The commencement of the electrification programme and the extension of this programme into rural areas saw an ad hoc approach to electrification by Eskom. Eskom became involved in rural electrification due to the constraints of its distribution licence which granted access to a few urban areas only. With little experience and knowledge of rural areas, Eskom committed itself to meeting annual connection targets. With fulfilment of these targets being the main driving force behind the electrification programme, little attention was paid to developing selection criteria. However, electrification planning has been under continual review and processes to standardise and improve planning have been put in place. Eskom hopes that this standardised approach will result in a more stringent least-cost approach to electrification.

What is interesting and important to this discussion on selection criteria is the apparent disjuncture between the approach of national and regional Eskom staff. Of primary concern to Eskom staff at the national office is the development of a least-cost approach to electrification planning. While recognising the importance of a least-cost approach, some regional Eskom staff question the practical implications of implementing an electrification programme based only on these parameters. This is clearly borne out of the tension which exists between reducing the costs of electrification and the enormous pressures for electrification which they experience from various community groupings. One of the main reasons for the drive from national office for the development of a least-cost approach is the realisation of the scale of the financial burden that is placed on Eskom by the electrification programme. Furthermore, Eskom hopes that the standardisation of the electrification planning process will begin to reduce the impact of political pressure, as well as the pressure from communities for electrification. However, due to the high community expectations with regard to electrification, as well as the commitment to the involvement of community forums in the prioritisation and selection of projects, it will be difficult to resolve this tension.

To date, both the national framework for consultation with communities and the five-year business plan have been finalised with a view to standardising the electrification planning process. The micro-level planning processes, which include the development of two- and one-year electrification plans, are in the process of being standardised (Richter 1996).

3. The allocation of targets

The allocation of national targets among the provinces is important in this discussion on selection criteria. The factors which shape the distribution of the national targets are consistent with Eskom's primary goal of meeting these targets, as well as ensuring a least-cost approach to electrification. So, while not necessarily concerned with selecting areas or settlements for electrification, this discussion is important as it provides an understanding of the framework within which electrification in the provinces occurs.

As a component of standardising Eskom's electrification planning, the utility has recently developed the 1997 five-year plan. The business planning process included the finalisation of national targets and strategies, the allocation of regional targets and the compilation of national and regional budgets (Eskom 1995a). Where previously the regions had little input into the business plan, the new standardised process has made provision for regions to contribute, thereby ensuring that different conditions in the regions are taken into account (Richter 1996). One of the central aims of this process was for each SACS region to develop a least-cost plan which would meet the connection and capital expenditure targets over time.

The following factors are taken into account when allocating targets (Eskom 1995a; Theron 1995):

- equitable share of targets between provinces;
- electrification status of the region – that is, the percentage of electrified and non-electrified households;
- Eskom's capacity in the region;
- Eskom's current resource allocations;
- growth areas (although not mutually exclusive, this refers to both growth in infrastructure, such as housing, as well as to economic growth areas); and
- political conditions in the region.

The way in which these factors interplay to produce the final division of targets in the provinces has led to target allocations which are predominantly concerned with ensuring that the overall national targets are met and costs are reduced.

Although the electrification status of the province is taken into consideration, targets are not allocated in direct proportion to the percentage of unelectrified households. This becomes clear if one examines the 1995 targets for Gauteng and the Eastern Cape. Gauteng, with 23% unelectrified households was allocated 44 000 targets while the Eastern Cape, with the highest percentage of unelectrified households (72%), was allocated 46 000 (NER 1995). Gauteng is a densely populated province with a predominance of peri-urban and urban settlements. Consequently, electrification is easily facilitated and cost reduction is possible. By contrast, the Eastern Cape includes the former homeland areas of the Transkei and the Ciskei where settlement patterns are dispersed and the electrification network not well developed; costs are significantly higher in the Eastern Cape than in Gauteng.

This is also true for KwaZulu/Natal, where Eskom has little access to urban areas (Gwala 1996). With most of its activity limited to rural areas, which are characterised by dispersed settlements and mountainous terrain, the cost of electrification is high. Furthermore, the political context, with its continuing violence and conflict, has an impact on electrification in the province. In the interest of reducing the cost of electrification, the KwaZulu/Natal targets for 1996 were reduced from 82 000 to 50 000 (Gwala 1996).

Although Eskom's distribution licence limits its activities predominantly to rural areas, it is apparent that those areas where urban electrification is possible for Eskom are prioritised. By skewing the allocation of targets in this way Eskom is more likely to achieve the national electrification targets. While this strategy clearly has its advantages in being able to reduce the costs, as well as meet the targets, it has implications for electrification in provinces where the percentage of unelectrified households is large. When selecting or prioritising settlements for electrification it becomes difficult to allocate connections within the regions. This is particularly true of regions where there are a

number of settlements which fulfil Eskom's criteria for selection – such as the proximity of the distribution network and the economic viability of electrifying (refer to discussion below for more details on these criteria). In the Northern Province, for instance, Regional Electrification Forums have challenged the way in which targets are allocated. A particularly difficult situation arose recently when areas in the former Venda were incorporated into the Northern Province SACs region. Instead of increasing the number of targets allocated to this region, the connections for 1996 had to be re-allocated within the region to fit the targets. The number of connections for each magisterial district had to be cut in order to accommodate connections in Venda. The forums in the Nebu district were particularly unhappy with this and Eskom was unfairly accused of an ethnicist approach to electrification (Lithole 1996).

Obviously, the electrification programme cannot focus only on provinces with a high percentage of unelectrified households, nor can it ignore the financial and technical considerations of electrification. Nonetheless, allocating targets to provinces on the basis of meeting national targets and least-cost parameters has implications for rural electrification. With such an approach little attention is given to assessing what conditions are necessary to ensure the maximum net benefits of electrification in rural areas. In other words, there are no criteria on which to base the selection and prioritisation of areas and settlements for electrification. As will be shown, the lack of clear criteria also has a significant impact on Eskom's ability to apply a least-cost approach. The discussion to follow will examine this in more detail.

4. Identification of settlements

As a component of the Eskom's electrification planning the five-year plan is concerned with numbers of connections and possible areas to electrify. In many regions, however, these five year plans include detailed micro-level planning with specific electrification projects already identified (van der Walt 1996; Sterley 1996). Two-year rolling plans and one-year plans, which involve the selection and prioritisation of particular projects, are devised and updated on a quarterly basis (van der Walt 1996). The identification and inclusion of settlements in the electrification plans can occur in a number of ways:

- Requests are made from community groupings, individuals or national and politicians to electrify certain settlements. If these settlements are not already included in Eskom's plans, the viability and cost of electrifying the area is evaluated.
- Using database information with regard to the settlement type and socio-economic indicators, settlements are identified for electrification. Databases in regional offices are used to evaluate all settlements which are possible sites for electrification.
- SACs staff visit areas and evaluate the areas according to brief interviews with a few residents. Based on their experience of the conditions necessary for electrification, assessments of the areas are made.
- SACS staff identify possible projects in the areas in which they work. Where settlements are within close proximity to existing projects these are often identified as project sites as a result of the low costs involved in expansion of the electrification infrastructure.
- In some regions the identification of settlements to be electrified is undertaken with electrification forums. With the recent establishment of local government, attempts are being made to undertake this process with the local governments.

5. Criteria for a least-cost approach to rural electrification

This section will outline the technical, financial and socio-economic factors which are taken into consideration in applying a least-cost approach to electrification. In line with the electrification planning process, these factors affect the selection and prioritisation of areas within provinces, as well as settlements. It is important to note that, while Eskom has a sense of how these factors influence the costs of electrification, they have not been developed into clear criteria which are rigorously applied. For example, it is known that the density of settlements influences the cost of electrification, with a direct correlation between high cost and low density. However, exactly how dense the settlement patterns should be in order to ensure reduced costs is not defined. Consequently, Eskom's aim of achieving the least-cost per connection is often not fulfilled.

5.1 Financial and technical criteria

In the process of selecting areas within the regions for electrification, technical considerations, which aim at reducing the cost per connection, are taken into account. Attempts are made to ensure that the connection cost per household is within the capital limit for rural areas. It is, however, difficult to gain clarity on Eskom's capital limit for rural electrification as figures given for this range from R3 000 (Barnard 1995) to R4 000 (Richter 1996). This is an indication of the lack of rigour in determining criteria for a least-cost approach.

The proximity of the grid and the load capacity (ADMD) should also be taken into account when selecting and prioritising an area for electrification (van der Walt 1996). Consultation between electrification planners, engineers and technicians is undertaken within the regional Eskom offices to establish this information. Furthermore, the existing electrification infrastructure and network, and planned expansion, are important factors in prioritising areas (Eskom 1995a). With grid extension costs high, areas further away from the grid are not likely to be placed on the immediate electrification plans.

During village selection procedures, technical considerations are also important. The distance of the village from the grid is one of the most significant factors taken into account in determining whether it is electrified; attempts are made to electrify villages which are closer to the grid.

Due to lack of information on the electrification networks, particularly in the former homeland areas, these factors have often not always been applied. Also, pressure from politicians and communities have led to these criteria being compromised. This is particularly true for the early part of the electrification programme (van der Walt 1996). It is hoped that the standardisation of electrification planning will begin to reduce the impact of these pressures. However, unless electrification planning guidelines include clearly defined criteria, it is unlikely that this will be achieved.

5.2 Settlement patterns, demographics and socio-economic criteria

Various indicators pertaining to the settlement patterns, demographics and socio-economic conditions are used to select and prioritise areas for electrification within each province. These include:

- the existing infrastructure (roads, telephones, buildings) of an area;
- other development initiatives in the area;
- level of economic activity;
- the availability of water;
- population;
- migration patterns;
- fuel expenditure patterns; and

- income levels (Eskom 1994; van der Walt 1996).

In areas where there is a discernible level of economic activity and infrastructural development, the financial risks of electrifying are reduced. A greater demand for electricity in such areas is likely to exist, with a greater potential for growth in demand. The stability of the population, hence the attention to migration patterns, is also important. Eskom would clearly like to avoid the electrification of areas where there is a large out-migration of people. For this reason, the availability of water is considered to be an important indicator of the ability of an area to sustain its population. This is borne out of the experience in Lebowa, where the drought and subsequent lack of water have contributed towards out-migration (Sterley 1996, Eskom nd). Where information on fuel expenditure patterns and income levels is available, Eskom attempts to calculate the demand profiles and assess the potential electrification consumption use and growth.

It is apparent that these factors have also not been developed into clear selection criteria. By way of example, while there is an understanding of the impact of the lack of reliable water sources, there is no clarity on how this affects village selection. For instance, are villages excluded from electrification plans because they do not have a reliable source of water? Or will villages only be selected for electrification once boreholes or standpipes are provided? In other words, what is the minimum water availability requirement before Eskom will prioritise an area for electrification?

The selection of specific villages for electrification is based on the following factors (Eskom 1994; Eskom nd; Richter 1996):

- size and density of the village;
- existing infrastructure (such as roads, telephones, water supply);
- existing businesses and business potential;
- types of dwellings;
- existence of schools and clinics;
- demand profiles per customer (largely determined by income level); and
- perceived social benefits.

The size and density of the village is important in determining the cost per connection. It is felt that dispersed settlements should not prioritised due to the high reticulation costs involved.

The number of households in a village will also influence the cost of electrification. In the process of prioritisation, electrification forums have insisted that only portions of settlements being electrified in favour of applying a fair distribution of the prescribed connection targets (Sterley 1996, Lithole 1996). Although settlements in the Northern Province and Mpumalanga are large, with two to three thousand possible connections per village, it has happened that only 250 connections are made in one village in favour of this principle of fair distribution (Sterley 1996).

Although portions of villages have been electrified in the past, establishing the minimum number of connections per village, in order to achieve the least-cost per connection, is believed to be important. Once again, it is not clear what this limit is. Some figures set the connection limit at that no less than 500 per village (Sterley 1996), whilst others suggest that the limit is 800 (Eskom 1994). In the case of villages where the number of households is less than the limit described above, the whole village should be electrified.

Settlements are assessed on the basis of the types of dwellings which are predominant. Traditional houses and brick structures are less costly to electrify than shacks, as the latter require the attachment of support poles. As with the selection process in areas, a reliable supply of water in villages is considered to minimise the risk of out-migration. Furthermore, poor road infrastructure makes access to villages for electrification difficult and costly. The existence of economic activity to sustain rural household incomes is considered important in determining the sustainability of an investment in the electrification of a village.

While the importance of using these socio-economic factors to select and prioritise villages is acknowledged, they have not been developed into criteria. Rather, subjective judgements are made by Eskom on the basis of a range of socio-economic factors which are considered to impact on the cost of electrification. Also, the lack of reliable information on the socio-economic circumstances in the regions has made it difficult to assess the viability of electrifying particular areas and villages.

5.2.1 The HELP database

Although the different SACs offices have used databases which include information on the villages and areas within their region, the information is not complete or accurate. This has made it very difficult to verify information gained from village representatives or residents who make requests to Eskom for electrification. Very often villages are not on these databases, or they have been entered under only one of a number of names by which the village is known. Also the demographic data has been found to be unreliable and inaccurate. In short, electrification planning has been made difficult. In some cases, this has led to the electrification of villages which were not viable – where, for example, incorrect numbers of potential households for electrification were given, leading to a negative impact on the cost of electrification.

As a result of the unreliability and lack of information on which to base electrification planning, Eskom is in the process of developing the Housing and Electrification Programme (HELP) database. This is a national database, with data captured for each region, which is expected to be an important tool for both short-term and long-term electrification planning. At present, the HELP database has been developed for the former Lebowa and Gazankulu regions, and will be continually updated.

Once the HELP database has been finalised, information concerning the number of households categorised according to size, services (water, electricity and sanitation), income profiles and housing type will be available for electrification planning. Due to the difficulties experienced with electrification planning in the past, as a result of the lack of adequate demographic and socio-economic data, electrification planning managers in the regions are optimistic about the important role the HELP database will play in electrification planning. This data will provide the basis on which to model least-cost network expansion plans.

6. Economic criteria

6.1 Cost benefit analysis

Due to the belief that electrification results in net economic benefits, all Eskom projects are economically evaluated through a cost-benefit analysis (CBA). Primarily concerned with the net benefits of allocating resources, CBA is a tool used to prioritise projects according to the efficiency of projects. Thus, CBA provides an analysis from a national perspective, rather than from the perspective of the implementing agency, such as Eskom in the case of rural electrification. Using the CBA model, the costs to society can be compared with the benefits, thereby ensuring that no alternative projects would secure a better result. The Net Present Value (NPV), Economic Internal Rate of Return (EIRR) and the Benefit to Cost Ratio (B/C) are the parameters used to make decisions on whether a project should be selected (Davis et al 1995).

Although both the economic and financial internal rate of return are calculated, Eskom's approval of projects is contingent on economic, rather than financial, viability. With broad acknowledgement that the electrification programme is not financially viable, an economic evaluation of electrification is undertaken in order to

- justify and motivate for financial subsidies and grants;
- be able to view the benefits more broadly than from an financial perspective; and
- ensure that projects contribute towards economic growth (Theron 1995b).

Using the CBA model, it is necessary for each project to be economically evaluated prior to seeking approval from the Capital Investment Committees (CIC) for funds. The results

of this evaluation are entered into the 'Form 15' which is submitted to the CIC. For projects to be approved a positive NPV (real EIRR of 6%) is required.

It is difficult to assess the efficacy of the use of CBA by Eskom as a means of selecting projects for electrification, for two main reasons. Firstly, there are disparate opinions within Eskom about the use of CBA as a means of project appraisal. Secondly, there is a certain degree of reluctance from regional staff to speak about the way it is used in the selection process. However, it is evident that the use of the CBA as a tool for project selection is not without its problems. In some regions there is little commitment to ensuring that the CBA is effectively carried out, as the cost per connection is considered to be a more important variable in project approval (Gwala 1996). Also, the CBA is often not undertaken properly as there is no capacity in the regions to do so and further training to use the CBA model is required.

There is a belief that the role which this economic analysis plays in approving the allocation of funding towards each electrification project is one of the main reasons why this tool is not effective. Rather than being used as an effective means of selecting economically viable projects, the CBA is used as a mechanism of project approval (Richter 1996). Although the distinction between selection and approval may seem trivial, when viewed in the context of the electrification programme it is significant. Enormous pressure to meet the annual targets is experienced in the regions. The economic evaluation of projects is undertaken quickly, with the costs not always accurately calculated. According to Richter (1996) this is particularly true for the long-term operating and maintenance costs. Furthermore, it is tempting to manipulate the model to achieve a positive NPV due to the need to fulfil the annual targets, with the result that some projects are approved despite their not being economically viable. Thus, CBA is considered the means to pursuing targets as the end goal of the electrification programme (Richter 1996).

Herein lies one of the central dilemmas facing rural electrification in South Africa. Devoid of a state policy framework for rural electrification, Eskom is left with the responsibility of allocating public resources to rural electrification projects. This means that these resources are restricted to Eskom's grid electrification programme without any state guidance or control over how they are allocated. Furthermore, by failing to provide a policy framework the state has absolved itself of the responsibility of ensuring the efficacy of an investment in rural electrification. The implications of this are far-reaching for the development of rural areas as these resources are exclusively available for grid electrification regardless of whether or not this service is prioritised in a specific locality. Thus, the potential for energy services to be met through other more appropriate or cost-effective energy options, such as photovoltaics or LPG, is not possible.

There is little doubt that CBA can be an effective tool for assessing the net economic benefits of an investment in rural electrification. It could assist with comparing the net economic benefits of electrification against non-grid or non-energy projects. With the immense challenge of achieving equity in the provision of services in South Africa, it is necessary to ensure that scarce national resources are allocated effectively and sustainably. However, it is clear that the target-driven approach of Eskom's electrification programme militates against the effective use of the CBA as a tool for project prioritisation. This approach to electrification is unlikely to shift in the near future due to Eskom's commitment to the government RDP, which sets out the electrification connection targets until the year 2000. Once this point has been reached, there is an opportunity to reform electrification planning to ensure a more effective use of CBA as a tool for project prioritisation. It will, however, be important to examine whether the CBA model used by Eskom is an appropriate tool for selecting projects on the basis of their net economic benefits. The approach taken in the model is conservative, with benefits such as time-savings to households, health and environmental benefits, forward and backward linkages, benefits to the macro economy, and income distribution effects, all not included (Davis 1995; refer to appendix 1 for further details).

6.2 Economic growth and development

As mentioned above, one reason Eskom gives for undertaking a CBA of electrification projects is to ensure that the projects contribute towards economic growth. This vision is

shared by a number of people in Eskom who were interviewed in this research. The assumption that electrification should contribute towards economic growth has led to an emphasis on prioritising economic growth areas in the allocation of national targets and identification of settlements for electrification. Due to the realisation that the cost of rural electrification is great, and that the rural electrification programme has the potential to place an economic burden on the country, this perspective is gaining favour amongst electrification planners in Eskom.

While there seems to be consensus amongst these planners that electrification should be situated with an economic development context, it is not clear what is meant or understood by this. For some, such an approach would necessitate an integrated approach to infrastructure provision (van der Walt 1996). For example, electrification should be linked to housing development or water provision. It is hoped that by adopting an integrated planning approach to service provision cost savings can be achieved, and the full potential of the benefits of electrification can be realised. Others felt that it was necessary to go beyond integrating electricity provision with infrastructural development; it was considered important that electrification be integrated with other development initiatives which may contribute towards economic growth. Examples of where such an integrated approach could be applied included the provision of electricity for irrigation in small-scale farming, as well as the development of commercial ventures in the sale of electrical appliances or repair services (Richter 1996). It was suggested that the most appropriate approach to rural electrification planning would be to prioritise economic growth centres or nodes. In these centres, an integrated approach to economic development and infrastructural provision should occur. By targeting economic nodes it is believed that the benefits of rural electrification will be maximised, and that electrification may help to accelerate this growth. In practice, it has seldom happened that areas are excluded from electrification plans due to the absence of any economic development. Also, precedence is clearly not given to economic growth centres.

Interviews with staff at the regional offices, however, revealed a slightly different perspective on selecting settlements according to economic growth criteria. Although there is consensus on the need to integrate the provision of electricity with other services and development initiatives, it was felt that the prioritisation of growth centres was considered to be inappropriate due to the high popular expectation of electrification (Mfeka 1996; Gwala 1996). Rather, attempts should be made to balance the need for ensuring economic benefits with the provision of services to areas which are unlikely to meet economic growth criteria (Sterley 1996; Mfeka 1996).

Although neither of the two contrasting perspectives discussed above are underwritten by any formal policy within Eskom, they reflect the international debates about the role of rural electrification in development. International opinion has shifted towards the perspective that rural electrification should be demand-driven. It is argued that electricity is unlikely to provide the stimulus for economic growth unless a range of other conditions, such as access to markets and materials, are fulfilled (Foley 1990; Schramm 1993). With a demand-driven approach, electrification of nodes is prioritised. International opinion also suggests that, where rural electrification is undertaken as a social investment, it should be subsidised by the state rather than the utility. Given that service provision in South Africa is concerned with social equity, attempting to balance the social and economic objectives of rural electrification is perhaps more appropriate than an approach driven exclusively on demand. An emphasis on selecting villages according to economic growth criteria alone runs the risk of foregoing other social benefits, such as water supply in rural areas or improved quality of lighting, which may occur with electrification.

7. A tension for a least-cost approach: community pressure

In line with the RDP principle of community involvement in development, Eskom is committed to consulting with communities in the electrification process. Although Eskom's consultation guidelines have been finalised, problems are still experienced with implementing them. This is largely due to the fact that some provincial governments, such as those of KwaZulu/Natal and the Northern Province, have failed to establish effective Provincial RDP Committees. Thus, the envisaged process, whereby Provincial Electrification Forums (which are an integral part of Provincial RDP Committees) prioritise areas for electrification, has not been extensively implemented. This has meant that there is little direction from provincial governments concerning the most appropriate areas to prioritise for electrification.

Linked to this institutional void is the absence of regional and national development strategies to provide a context for rural electrification. With little thought given to the role of electrification in rural development, it is not surprising that provincial governments are unable to provide guidance to Eskom on the prioritisation of areas for electrification. This situation compounds the tension experienced between the need to assert a least-cost approach and high expectations for electrification.

This tension is felt strongly by Eskom staff who deal with communities on a day to day basis. Many of the SACs officers have a great affinity and empathy with community aspirations for electricity. On a personal level this makes their job extremely difficult as they bear the brunt of the dissatisfaction of the communities which are not on the electrification plans (Mfeka 1996). Furthermore, there exists a strong ideological commitment by these SACs officers to ensuring that rural people are centrally involved in the prioritisation and selection of settlements for electrification. For example, there has been debate between national and regional Eskom staff about whether communicating the five-year plan to regional electrification forums is appropriate. The reason for this is that, once it is known that a village will be electrified, Eskom finds itself in a difficult position if the more detailed planning process reveals that electrification of the village would not be viable. While national staff have felt that it would be more appropriate not to communicate the five-year plans, some SACs staff have a commitment to ensuring transparency of Eskom's plans (Lithole 1996).

It was also evident that regional staff felt that the national office did not appreciate the problems experienced with holding the tension between a strong emphasis on least-cost per connection and community aspirations. In light of Eskom's campaign of 'Electricity for all' in the early stages of the electrification programme, regional staff have found it difficult to argue for a least-cost approach to electrification. The fact that Eskom 'promised electricity' is often raised by community groupings (Mfeka 1996).

Problems have also been experienced in the transition from consultation with sub-regional electrification forums to local governments. At the time of this research, the Northern Province local government councillors had rejected the plans which had been finalised by the sub-regional forums. The legitimacy of these forums was questioned by local government councillors. It was argued that local government should take responsibility for prioritisation of projects due to the provision of electricity being a local government function (Lithole 1996; Sterley 1996). It is interesting to note that some of the community leaders who were members of the forums have become local government councillors. Their ability to manipulate the electrification process reflects the significant role which politics plays in determining which villages are selected for electrification. The need to locate electrification planning within a rural development framework is therefore apparent. If the selection of villages was undertaken according to criteria which were established on the basis of a clear understanding of the role of electrification in rural development, such influences would possibly be minimised.

Clearly, it is imperative that communities are centrally involved in the electrification planning process at both regional and local levels. However, unless a rural development framework for electrification is developed, and provincial government involvement is

ensured, it is likely that Eskom will continue to be manipulated by community groupings and politicians.

8. Conclusion

The ultimate goal of Eskom's national electrification programme is to meet the annual connection targets. Areas for electrification are selected with this in mind, rather than on criteria which would maximise the rural development benefits of electricity. Coupled with this, a move towards a more rigorously applied least-cost approach to electrification has occurred. Due to the realisation of the scale of the financial burden that the electrification programme has placed on Eskom, attempts are made to ensure that areas and villages are selected according to a least-cost per connection principle.

Although there are a range of factors which influence selection and prioritisation, no clear criteria have been developed to ensure that electrification occurs within least-cost parameters. For example, it is known that the density of settlements influences the cost of electrification, with a direct correlation between high cost and low density. However, the exact density of a settlement which is required in order to reduce costs is not known. In the absence of clear criteria it is difficult to implement a least-cost approach to electrification.

Political and community pressures for electrification have an impact on the cost of electrification. Furthermore, there is some debate about whether a least-cost approach to electrification is appropriate. Eskom staff in the regions, who work with communities and are subject to the high popular demand for electrification, feel that a least-cost approach stands in opposition to achieving the aims of social equity.

Differences of opinion also exist about prioritising economic growth centres or nodes for electrification. Some electrification planners within Eskom believe that economic nodes should be targeted because it is believed that the benefits of rural electrification will be maximised, and that electrification may help to accelerate this growth. Others, however, feel that a balance between the economic and social objectives of rural electrification should be achieved. Neither of these perspectives is underwritten by formal Eskom policy, although there is ample reference to the role of rural electrification in economic development. Herein lies one of the central problems with rural electrification in South Africa. The electrification programme is not situated within a rural development framework. Consequently, the annual targets provide the framework for project selection and prioritisation, with little emphasis on devising selection criteria which will ensure that electrification has an impact on rural development. Until such a framework is developed, it is unlikely that there will be clear guidelines for the selection of electrification projects which will have a significant impact on the lives of rural women and men.

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APPENDIX
The economic benefits of electrification

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A financial analysis of an electrification project captures the costs and revenues experienced by the utility. However, since tariffs are usually based on a utility's costs, it is quite likely that revenues do not accurately reflect the value of electricity to the consumer or to the country. An economic analysis attempts to capture the '*true*' costs and benefits of a project and weigh them up against each other. Economic costs can generally be calculated with some certainty using established parameters. However, benefits can be much harder to quantify and express in monetary terms.

This short paper attempts to summarise some of the benefits which are commonly associated with electrification, and to review relevant South African research.

1. Direct benefits to the user - the `consumers' surplus' and time savings

An individual household, business or public facility will experience direct financial benefits as a result of access to electricity. These can be listed as cost savings on alternative fuels, and improved quality, versatility and convenience in energy use.

The extent to which a household achieves savings on monthly energy expenditure will be a function of the cost of alternatives and the extent to which a household switches to electricity. As is well known, the switch to electricity in low-income households may be slow, as it takes time to acquire appliances and households may prefer to continue using other fuels for specific end-uses. Lighting, radio, television and, to a certain extent, ironing are low-consumption, high-value uses for electricity. Most households switch to using electricity for these applications quickly, either because of the higher quality service which electricity provides (such as lighting), or because of the high cost of alternatives (batteries, for example). Refrigeration is also a high-value end-use, but where the cost of the appliance may prohibit extensive use. Thermal applications, such as cooking, heating and water-heating, on are high-consumption applications where it is common for the cost of alternatives to be relatively low. The switch to electricity for these end-uses is slower and the savings to users are smaller.

Figure 1 shows that with a few exceptions (such as coal for cooking and heating) electricity offers cost savings to users. The extent to which a household realises these savings is a function of the fuels displaced and the end-uses of these fuels. If the cost of all displaced fuels is taken into account, the household achieves a saving on energy costs. Table 1 shows, on average, how much energy is displaced by electricity in newly electrified households, and what the saving is.

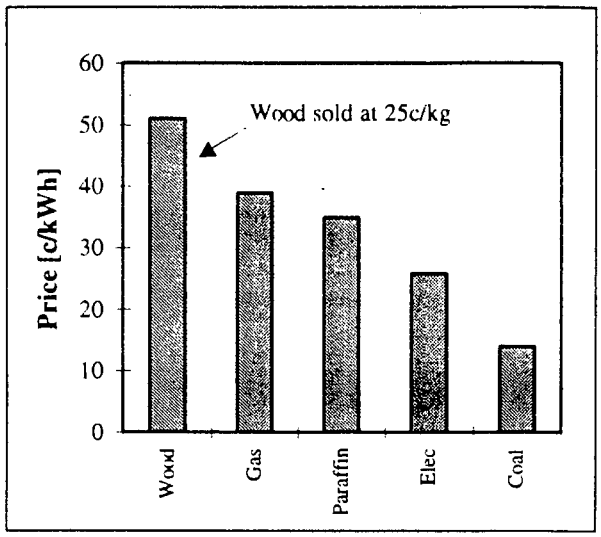

FIGURE 1 Comparative cost of fuels for cooking purposes

Energy displaced	*Equivalent price*	*Monthly saving*	
	[kWh/month]	*[c/kWh]*	*[R/month]*
Rural household	60	40	24
Urban household	70	38	27
Metropolitan household	120	35	42

Note: These results are based on an analysis of extensive survey data (SALDRU, 1995). As households use electricity for more end-uses (i.e. as energy displaced increases), so the equivalent price decreases.

TABLE 1 Energy savings in electrified households

For larger shops, productive enterprises, and even schools and some households, electricity often replaces diesel generators. In these cases the savings from a switch to electricity can be quite substantial as the unit cost from gensets can be well over R1.00/kWh (Davis & Horvei 1994).

In addition to displacing certain fuels, electricity allows households to extend the range of energy services used. It is not uncommon for net energy consumption to actually increase with access to electricity. Although this does not result in direct cost savings to households, it is still true that the price of electricity may not reflect the value of this additional consumption to these households. In these cases it is possible to construct a demand curve and estimate the benefit in addition to monthly expenditure savings. A straight line demand curve is often used as an approximation.

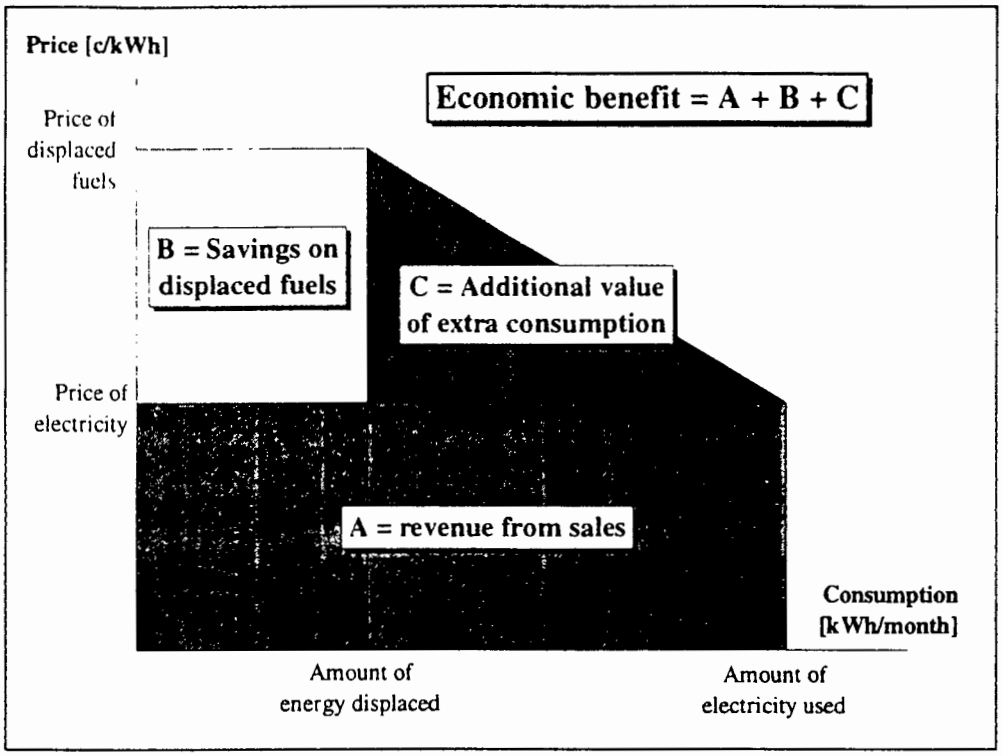

FIGURE 2 Measuring the direct economic benefits to users: the consumers' surplus

Electricity also provides certain notable qualitative advantages over other fuels. The convenience, versatility, cleanliness and safety of grid power are all important to households. However, it is extremely difficult to value these benefits in any concise way. Similarly, it is often claimed that access to electricity improves the quality of life, through access to lighting, street lighting, television and so on. As before, it can be difficult to quantify and measure these effects.

Fuelwood collection in rural and some peri-urban communities is often a time-consuming and burdensome task, largely undertaken by women. If electrification results in decreased wood consumption, there may be savings in women's time, which can be valued. However, evidence suggests that wood use continues after electrification (Davis & Ward 1995), particularly in rural areas and so inclusion of this factor may well overstate the benefits of electrification.

Other time savings may be associated with the reduced time required for domestic tasks (particularly cooking) and increased productivity, especially associated with good quality light in the evenings. The extent to which these benefits exist and can be measured depends on the use of electricity and nature of evening activities. At present there is inadequate information to evaluate and quantify these effects.

2. Other economic benefits

2.1 'Backward linkages' - additional inputs

'Backward linkages' refer to the stimulus given to the economy by the need to provide additional inputs to electrification. These include:

- the ***direct inputs*** (materials and labour) required to construct electrification projects;
- the ***indirect effects*** associated with the 'up-stream' stimulation of the supplier and appliance industry; and
- the ***derived effects*** as salaries and profits are ploughed back into the economy in the form of private spending.

Eckert et al (1993) examine the possible effects of appliance acquisition by newly electrified households. Although they state that the economic impacts of household appliance purchases, including job creation, value added and GDP growth, will be significant, these effects are likely to be diffused over an extended period. Also, expenditure on appliances will be traded off against future consumption on other commodities, thereby offsetting potential growth in other sectors against the benefits of appliance demand. Nationally, appliance sales have continued to grow over the past five years (van Gass 1993), although past trends may not accurately reflect the future as lower income households are increasingly included in the electrification programme. The danger of extrapolating past trends is emphasised by the high income-elasticity of electrical equipment (Martins 1989).

2.2 'Forward linkages' - additional outputs

'Forward linkages' refer to the effect that electrification may have on production in newly electrified areas as a result of electrification. This may refer to improved and increased production at existing enterprises as well as the creation of new productive enterprises, particularly micro-scale businesses. However, the quantification of these effects is hampered by the limited amount of relevant research conducted in South Africa to date.

Electricity has often been observed to have a beneficial effect on existing retail activities (Davis & Nghikembua 1995, Borchers et al 1994) – the use of refrigeration and lighting improves the quality of commercial services and allows shops to stay open later. However, it is not clear to what extent this actually increases the turnover and profit of a retail business.

Electricity may also allow the creation of small-scale home-based businesses. Again retail trade is a common example, although there are also opportunities created for sewing enterprises, workshops, bakeries and so on. DRA (1993) found that 7.5% of households in a survey of four electrified settlements had started a small-scale business, and this was mostly concentrated in the urban portion of their sample.

Rural electrification has often been justified by the perceived benefits to agricultural activities, most notably through the use of electrical water pumps for irrigation and machinery for crop processing.

It is important to realise that although electricity can play a role in stimulating economic activity, it is often only significant when viewed as complementary to other inputs. Factors such as access to credit, markets, training, transport, water and so on may prove to be just as important as electricity. Since access to electricity may be a necessary but insufficient condition for economic development, it would be inappropriate to allocate the full benefit of such development to electrification alone.

The quantification of forward linkages requires a good understanding of the extent to which the benefits are actually realised, and the conditions under which they might occur. Although appropriate research may allow such benefits to be calculated and aggregated on a macro scale, it is extremely difficult to justify their inclusion in a project appraisal. The site-specific factors are likely to be critical in the realisation of these benefits and it is almost impossible to provide 'rules of thumb' to allow estimation of these benefits prior to electrification.

3. Health, safety and environmental benefits

The health risks associated with the use of coal, wood, paraffin and candles have been conclusively demonstrated (MRC 1995). The combustion of coal and biomass fuels in the home (and nearby homes) exposes family members to dangerous levels of particulates and gaseous products, increasing the risk of respiratory illness (van Horen 1993). However, it is estimated that as much as 90% of households in a highveld community would have to switch from coal to electricity in order to reduce particulate levels to within acceptable levels (MRC 1994). Households may perceive improved air quality to be of great value, however this is difficult to quantify and value.

South Africa has a burn mortality rate approximately four times that of industrialised countries, accounting for 11% of mortality among 0-14 year olds. (MRC 1995), and over two-thirds of burns can be attributed to dangerous energy sources. Paraffin poisoning is extensive in unelectrified communities, with approximately 16 000 children being hospitalised annually as a direct result of ingesting paraffin (MRC 1995).

Although non-electrical energy use has severe health risks, the beneficial effect of electrification will depend on the extent to which households switch from other fuels. The transition to electricity appears to be slow and the factors affecting it not well understood. Davis & Ward (1995) report that only 10-15% of low-income rural electrified households use electricity to cook and, of those that do, most still combine electricity with other fuels.

Research conducted by the MRC (1995) has shown that the health-related economic benefits of electrification are small in comparison with the costs, even with optimistic assumptions regarding the extent to which households switch to electricity. However, the social value of reduced health risks may well be large.

An additional health and education related aspect to electrification is the supply of electricity to schools and clinics in rural areas of the country. Government has identified this as an important policy objective (RDP 1994) and, along with Eskom as well as local and international donors, is committing substantial sums of money to this end. Where grid electricity is not available, off-grid systems are being installed at a cost of approximately R60 000 per clinic and R40 000 per school (Thom et al 1995). Expenditure on grid electrification of schools and clinics means that the cost of off-grid systems is avoided and this saving can be attributed as a benefit to the project.

Many areas of South Africa have experienced serious woodland denudation, resulting in erosion, reduced soil fertility and increased social costs of wood collection. It is often speculated that electrification can help address this problem. However, woodland denudation is usually the result of other factors such as overcrowding, overgrazing, land clearance for agriculture and wood collection for construction and fence-building. Fuel collection is often only a minor cause. Even if households switch to electricity for cooking on a widespread basis, the effect on woodland denudation is likely to be small.

4. Macro-economic effects: GDP growth, employment creation, capital requirement and income distribution

A macro-level analysis of the benefits of the electrification programme should include consideration of the effects on GDP, job creation, capital requirement and the national balance of payments. Conningarth Consultants (1995) have attempted to quantify these effects, including appliance acquisition, income substitution and capital investment.[1] It was concluded that the electrification programme after ten years will have:

- created R8 bn of GDP,
- created 125 000 job opportunities, and
- required R21 bn in capital.

In comparing these with figures for other sectors of the economy, it was concluded that the returns are 'mediocre'. However, a full cost-benefit analysis was not included within the scope of this study.

Since the principal beneficiaries in most electrification projects are low income household, electrification projects will usually result in positive income distribution effects. However, within this target group higher-income households are likely to benefit more since appliance acquisition and electricity use will be influenced by household income. The

[1] Although electrification may have some effect on the balance of payments as materials are imported for transformers, appliances and so on, these effects are generally considered to be relatively small. In other countries where imported oil is used to generate electricity, increased electricity consumption can significantly increase the amount of foreign exchange required. This is largely irrelevant in South Africa.

inclusion of income distribution effects in a cost-benefit analysis requires the determination of weights with which to value distribution. The determination and use of these 'social weights' is controversial and difficult.

5. Capturing the benefits in Eskom's economic analysis package

Eskom uses a financial and economic analysis package to appraise potential electrification projects. The financial analysis presents the impact of the project on Eskom, whereas the economic analysis attempts to capture the economic worth of the project. The objective of such an appraisal is to identify projects with the greatest economic benefit-to-cost ratio. The approach taken in the model is essentially a conservative one: it is recognised that the type of research necessary to confidently quantify many of the benefits discussed in this document is both difficult and costly. The model includes the following benefits:

- *direct benefits to consumers* (the consumers' surplus) measured by the willingness to pay for electricity; and
- *avoided costs on off-grid systems* to schools and clinics.

Benefits *not* included in the model are:

- *time savings* in the household;
- *health benefits* as a result of reduced risk of respiratory illness, burns, fires and paraffin poisoning;
- *environmental benefits* associated with reduced wood collection and air quality;
- *forward and backward linkages* to the economy;
- the *benefits to the macro economy* in terms of job creation and GDP growth;
- and *income distribution* effects.

As a result, the economic net present value from the model should be taken to a conservative estimate of the true economic result. Consequently a marginal result should be acceptable, that is an economic net present value for the project close to zero.

Although health and macro-economic benefits could feasibly be incorporated into the model, their inclusion would in all probability be extrapolated from national results. As a result there would be little value for *distinguishing between projects*. An area of potentially fruitful and useful research would be the identification of conditions favouring the productive use of electricity. This would be of great value in selecting electrification sites within the framework of cost-benefit analysis.

6. Summary

The table below summarises the economic benefits of electrification and comments on their applicability and measurement.

Benefit	*Definition*	*Comment*
Consumers' surplus	The direct economic benefits to the user comprising of revenue from sales, savings on alternatives and the value of extra energy consumption.	Measured using willingness to pay, electricity consumption and amount of displaced energy (see Figure 2).
Time savings	Associated with reduced fuelwood collection, domestic tasks and increase in productivity.	Few rural households switch to electricity for cooking and so time savings on wood collection are small. Other aspects require further research.
Backward linkages	Any economic stimulus as a consequence of electrification. This includes direct inputs (materials and labour), indirect effects (stimulation of upstream industry) and derived effects (private consumption).	Can be measured using social accounting matrix, but largely useful only on a macro scale and not for distinguishing between projects.
Forward linkages	Improved production at existing businesses and the creation of new enterprises.	Important, but requires more local research to use effectively in a project appraisal tool.
Health & safety benefits	Reduced risk of respiratory illness, burns, fires and paraffin poisoning.	Avoided costs appear to be relatively small, but social value potentially very high.
Environ-mental benefits	Reduced pressure on natural woodland and improved air quality in the home and neighbourhood.	Electrification is likely to have little impact on woodland denudation. Perceived value of air quality likely to be high, but difficult to quantify and value.
Macro-economic effects	GDP growth, employment creation, capital requirement and effect on balance of payments.	GDP:capital ratio and employment:capital ratio appear to be 'mediocre' in comparison with other economic sectors.
Income distribution	If benefits accrue to low-income households, this can be perceived as of greater value than if benefits went to high-income households	Quantification requires the determination of a set of weights with which to value income for different income categories. This is controversial and difficult.

TABLE 2 Summary of economic benefits of electrification

References to Appendix

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Criteria used for the selection of electrification projects in rural areas

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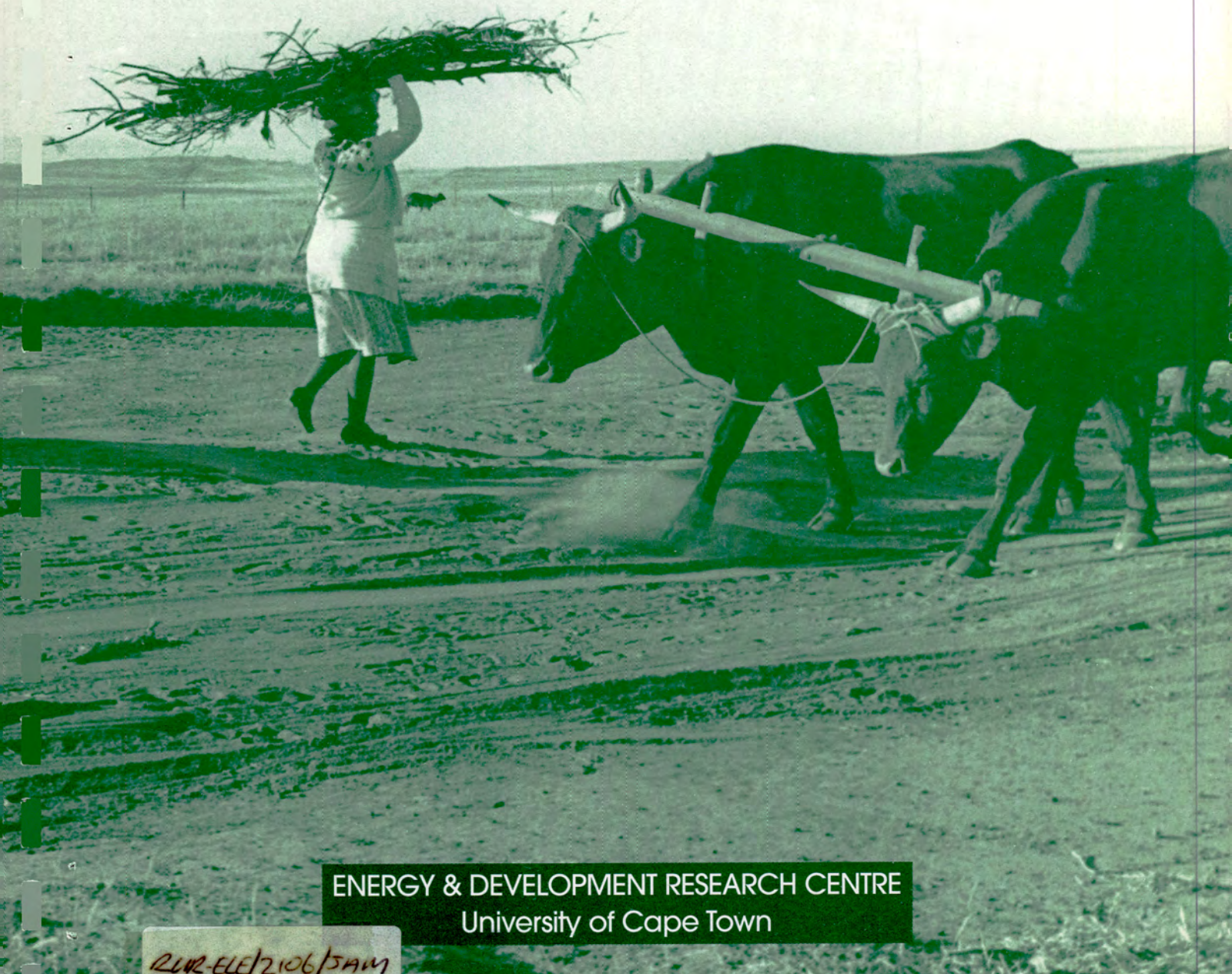

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