Rural electrification in South Africa

SUMMARISED RESEARCH FROM THE PROJECT: THE ROLE OF ELECTRICITY IN THE INTEGRATED PROVISION OF ENERGY TO RURAL AREAS OF SOUTH AFRICA

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ENERGY & DEVELOPMENT RESEARCH CENTRE
University of Cape Town

Contents

Introduction

This publication presents, in a concise, summarised form, the main research outputs of a comprehensive research project on 'The role of electricity in the integrated provision of energy to rural areas of South Africa', conducted over three years by the Energy and Development Research Centre at the University of Cape Town. The overall aim of the project has been to assist with the development of rural electrification policy that is consistent with South Africa's national and regional development goals.

The project reviewed rural electrification experience, both within and outside South Africa, before taking a systematic look at a range of practical implementation and policy issues. Over the three years a total of 45 research reports and papers have been prepared by EDRC staff as well as researchers from a range of other organisations around South Africa. The reports have been subject to review by South African experts in the various topics and, in addition, the more recent papers have been reviewed by a number of international rural electrification specialists – Gerald Foley, Elizabeth Cecelski, Venkata Ramana and Tore Horvei.

The project was funded by the Norwegian Development Agency, the South African Department of Minerals and Energy and Eskom.

It should be stressed that the papers presented here are highly compressed and summarised versions of the research papers, which are available in their full versions as indicated below. These summaries, therefore, are not fully referenced, nor should they be taken as giving more than an indication of the material covered by the full papers. Interested readers requiring more depth of discussion are encouraged to turn to the original papers. At the end of each summary a list of references indicate the report(s) from which the summary has been drawn. A select list of the Project's reports is given at the end of this introduction.

The research areas covered by the project

1. Background information

International literature review
Review of South African experience
Energy demand data analysis

2. Case studies

A number of case studies were undertaken with the aim of assessing the impacts of electrification amongst rural villages, at schools and clinics, amongst workers on commercial farms, and small-scale farmers.

3. Operational policy

Planning data resources
Policy and criteria for the selection of rural electrification projects
Project appraisal/cost-benefit analysis methodology
Technology/supply options
Acceptability of different electricity supply options primarily current-limited supplies
Financial and economic analysis of supply options
Evaluation of grid and non-grid electricity supply options
Community participation in rural electrification

4. Public policy

The development context
Integrated planning framework for rural electrification
Rural electrification scenarios – financial analysis
Role of rural electrification in development

The role of rural electrification in promoting health, education, small business development, small-scale agriculture in South Africa.
Equity and empowerment in rural electrification programmes.

Getting hold of the research

A number of the research reports are available for free from our internet web site. They are also available in printed versions, at cost price (the price depending on the length).

See the EDRC website at: www.edr.uct.ac.za

Printed copies may be ordered from our website, or by contacting Ethney Waters at:
Email: ethney@energetic.uct.ac.za
Fax: (021) 650 2830
Tel: (021) 650 2824 (mornings)

A select list of the research papers

Annecke, W . Integrated energy supply policy.

Auerbach, R. Impact of electrification on small-scale farming: A field study of the electrification process at Nhlangwini in Southern KwaZulu/Natal.

Banks, D. Criteria to support project identification in the context of integrated grid and off-grid electrification.

Banks, D. Off-grid electrification for the poor: constraints and possibilities.

Banks, D & Thom, C. Criteria for integrated grid and off-grid electrification planning: Summary paper.

Bedford, L. Electrification of clinics and schools in the former Transkei: Pre-electrification study in Mnceba, Ludeke, AmaNdengane and AmaNtshangase.

Bedford, L. An assessment of the process of the electrification of clinics in Region E of the Eastern Cape.

Bedford, L. An assessment of the process of the electrification of schools in Region E of the Eastern Cape.

Bedford, L. Electrification of schools in Region E, Eastern Cape. Post electrification study in Ludeke and follow-up in Mnceba.

Bedford, L. Electrification of schools in non-grid areas in Region E, Eastern Cape. Post-electrification study in AmaNtshangase and AmaNdengane.

Bedford, L. Electrification of clinics in Region E, Eastern Cape. Post-electrification study in AmaNtshangase, AmaNdengane, Ludeke and follow-up in Mnceba.

Borchers, M, Hofmeyr, I-M. Rural electrification supply options to support health, education and SMME development.

Crawford Cousins, C. A question of power: the electrification of rural households.

Davis, M. A financial and economic analysis of two electrification projects.

Davis, M. The financial impacts of rural electrification.

Davis, M. Institutional frameworks for electricity supply to rural communities: A literature review.

Davis, M & Ward, S. Household energy-use patterns in rural areas: The effects of access to electricity.

Development Planning & Research. Electrification and rural water supply.

Gordon, A. Facilitating education in rural areas of South Africa: The role of electricity and other sources of energy.

Hansman, C. Synthesis document: The pre-electrification of Santombe.

Hansman, C, Van Gass, M, Annecke, W, Despins, P and Kargas, S. The post-electrification of Loskop.

Hofmeyr, I-M. A comparative study of the access to and use of electricity by farmworker households in the Free State.

James, B. Community participation in rural electrification: Community based organisations for operation, maintenance and administration in rural electrification.

James, B. Community participation in rural electrification: Building human capacity through the delivery of electricity to rural areas.

James, B. Equity and empowerment: Possible outomes of a rural electrification programme?

James, B. Current-limited supplies of electricity in the context of South African rural areas.

James, B. An assessment of the pre-electrification process in the Tambo village project.

James, B. The impacts of rural electrification: Exploring the silences.

James, B, Ntutela, P. Rural households' response to the 2.5A electricity supply option in the Tambo village pilot project.

Rogerson, C M. Rural electrification and the SMME economy in South Africa.

Ross, F, Matzopoulos, R, & Phillips, R. The role of rural electrification in promoting health in South Africa.

Simmonds, G. Revenue management in rural electrification; The administrative and operational costs of community-based organisations.

Steyn, G. Rural electrification: Delivery or development?

Tapson, D. The role of electricity in the development of small-scale agriculture in South Africa.

Thom, C . Criteria for the allocation of electrification resources to provinces

Thom, C. Planning considerations for rural electrification.

Thom, C. A planning framework for rural electrification: The emerging institutional framework for the provision of public services in rural areas.

Thom, C. Pre-electrification research in Mafefe: Energy use, livelihoods, power relations and the electrification process.

Thom, C, Davis, M & Borchers, M. Review of South African experience in rural electrification.

Van Horen, C & Thompson, B. Sustainable financing of electrification in South Africa.

Wentzel, M. Electricity supply options for the very poor.

Wentzel, M, Manzini, M, Mulaudzi, C, Sehlapelo, D & Wood, C. A post-electrification study of the Mafefe electrification project.

1
Financing rural electrification

Three reports specifically investigated the financial issues relating to rural electrification:

- *A financial and economic analysis of two electrification projects:* details the results of financial and economic analyses of two rural electrification projects undertaken by Eskom. It provides insight into the financial viability of rural electrification projects.
- *The financial impacts of rural electrification:* reports on a modelling exercise undertaken to investigate the financial impacts of the national rural electrification programme. It details the levels of subsidy required to sustain the programme.
- *Sustainable financing of electrification in South Africa:* examines the financial viability of proposed regional electricity distributors (REDs) in South Africa, and examines the level of support and/or tariff adjustments required to make these new utilities financially viable. An accompanying report 'Cross-subsidies and sensitivities: Further analysis of sustainable financing of electrification in South Africa' examines these issues in further detail.

The financial and economic viability of electrification projects

Two electrification sites were chosen for a detailed financial and economic analysis: Loskop, in KwaZulu/Natal, is a community of around 1000 households and has been completely electrified over the past few years. The electrification project has primarily been reticulation infrastructure. Mafefe, in the Northern Province, is a dispersed area containing over 30 villages. Of these, four settlements were electrified in the first phase of the project by means of a 22 km extension of the grid. Approximately 650 households received electricity as a result.

The methodology used for the financial and economic analysis was a cash flow model, which calculates the net present value (NPV) of annual cash flows, taking into account a range of costs, revenue and other benefits. In the economic model, additional benefits incorporated into the analysis were the consumers' surplus, as well as health and safety benefits associated with reduced fire hazards and paraffin poisoning. Additional economic benefits may well exist, but these have not been incorporated into the model. The results indicate that the projects are not financially viable for the utility, and that the total net present value of required subsidies is in the order of R2 000 and R4 000 per household (for Loskop and Mafefe respectively). In the case of Loskop, the prepayment meter option appears to require the lowest subsidies, while all three options produce similar results in Mafefe. The difference between the two sites can be mainly attributed to the 22 km grid extension required at Mafefe and the fact that the community is significantly smaller.

Financial and economic net present value of the projects

	Financial NPV per connection		*Economic NPV per connection*	
	Loskop	*Mafefe*	*Loskop*	*Mafefe*
Prepayment	(R2 200)	(R4 100)	R3 000	R2 100
Load-limited	(R2 500)	(R4 000)	R1 600	R1,000
Solar systems	(R3 950)	(R3 950)	(R1 350)	(R1350)

The economic analysis reveals that both projects are economically viable for grid electrification, with high rates of return. This can mainly be attributed to the estimation of fairly substantial positive externalities, primarily health and safety benefits as well as a consumer's surplus. It can be seen that for both projects the prepayment system generates the most economic value, due to the greater benefits associated with the use of a wider range of end uses/services.

The analysis of the conditions under which each supply technology is optimal has shown that load-limited supplies are preferred, from the utility's perspective, at consumption levels of less

than 150 kWh/month per customer and relatively short distances from the grid. For consumption levels higher than this, prepayment systems generate fewer losses. At low consumption levels (less than 50 kWh/ month), off-grid supplies are optimal for even very short distances from the grid (as little as 20m per connection). Where consumption is higher, off-grid systems only become financially attractive to the utility in the case of communities which are further from the grid. If the same analysis is performed from an economic perspective, it is apparent that prepayment metered supplies are optimal over a much greater consumption and distance range, that the niche for load-limited systems is restricted to lower consumption levels, and off-grid systems are optimal at only much greater distances from the grid.

The financial impact of rural electrification

The results from a modelling of future capital costs were used, together with the connection profile and assumptions regarding tariffs, other costs and consumption growth, to construct a cash flow model of rural electrification for the country. The resulting cash flow was then used to analyse the net present value and required subsidy for rural electrification. The key results are summarised below.

- If the proposed connection targets are met outside main urban areas, then access to electricity in these areas will reach 50% by the year 2000, and 67% by 2010.
- Average capital costs are R4 740 per connection, and there is a clear trend towards higher costs as the programme progresses. If capacity differentiated supplies are not used, capital costs increase, on average, by 30%. The cost penalty is particularly severe towards the end of the programme as more remote locations are reached.
- The NPV of the programme is highly negative at negative R13.8 billion, which is equivalent to negative R3 500 per connection. A sensitivity analysis showed that this result is strongly sensitive to capital costs, although the NPV remains negative even if capital costs decline by 30%.
- If all financing requirements are met through debt, then the total accumulated debt in 2011 will be R38 billion, equivalent to R9 500 per connection. This debt is over three times the depreciated value of assets at this time (where assets are depreciated over 20 years).
- An average subsidy of 17c/kWh, or R32 per customer per month, would suffice to keep debt within acceptable levels. If no debt is allowed at the end of the programme, then much higher subsidies are required – in the order of R1.2 billion per annum.
- Financial indicators for urban areas show a 20-30% improvement over those for non-urban areas, as shown in the table below.

Comparison of urban and rural electrification

	Rural	*Urban*	*Difference*
Ave capex/connection	R 4 740	R3 850	20%
NPV/connection	R3 500	R2 280	35%
Subsidy/connection	R32/month	R22/month	30%
Subsidy/kWh	17c/kWh	11c/kWh	27%

As is widely believed, rural electrification is not financially viable, and extensive subsidies are required to cover losses. This analysis has quantified the extent of these subsidies, and has shown that it is capital costs, rather than operating losses, which drive the financial impact of the programme. This suggests that major cost saving gains are to be made in considering innovations in supply technologies rather than in operating procedures.

The financial viability of regional electricity distributors

The first conclusion emerging from the study is that two of the five REDs – Northern (covering Northern Province, North-West and Mpumalanga) and Central (covering Eastern Cape, much

of Northern Cape and Free State) – 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).

Results for a ten-year period

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

This financial situation raises difficult policy questions, as it indicates that the 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:

- First, 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.
- Secondly, a mechanism could be established through which transfers are made from healthy to unviable REDs, based on as yet unspecified criteria.
- 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.
- Finally, the boundaries of the REDs could be re-drawn in such a way that each remaining distributor is financially viable on its own. This would not obviate the need for subsidies, but would mean that all subsidies are sourced from other electricity consumers within each RED.

Conclusion: the need for a new financing mechanism

While rural electrification has the potential to offer net economic benefits, it is clear that at existing tariffs most projects are not financially viable. The viability of rural electrification to date has hinged on extensive cross-subsidisation within Eskom. Not only is the continuation of cross-subsidies questionable in the context of market liberalisation and Eskom restructuring, but proposals to restructure the distribution industry into a small number of regional electricity distributors threatens to strand certain REDs in financially unviable positions.

For electrification to continue beyond 1999 new financing arrangements need to be established which do not prejudice industry restructuring initiatives. While various options have been proposed, no clear mechanism has yet been detailed or modelled against future electrification scenarios. It is imperative that a new system for electrification financing be designed.

References:

Davis, M. 1997. A financial and economic analysis of two electrification projects.

Van Horen, C & Thompson, B. 1998. Sustainable financing of electrification in South Africa..

Davis, M. 1996. The financial impacts of rural electrification.

2
Criteria for integrated grid and off-grid electrification planning

Key findings are presented here on:

- criteria for the allocation of grant funding for electrification to different provinces, and
- criteria to support the identification and selection of electrification projects.

Criteria for the allocation of grant funding to the provinces

Some recommended criteria for the allocation of grant funding available at a national level for the electrification of poor and historically neglected areas and communities to the provinces in South Africa are discussed here. It is not yet clear how, by whom and to whom such allocations will be made. Nevertheless, whatever the nature of the actual funding streams, government will need to guide the allocation of available resources to the different provinces. This is important for planning purposes, as the provincial governments are responsible for planning and co-ordinating a range of development sectors. It is equally important from a political perspective.

The social and economic objectives of the electrification programme have not been clearly defined as yet. Nevertheless, these seem to be addressing poverty, on the one hand, and, on the other, supporting economic development. For the purpose of this discussion a distinction is made between electrification projects that contribute to economic growth, and those that support broader socio-economic development.

Grant funding for projects that contribute to economic growth

For the purpose of this discussion 'economic growth' can be defined as a quantifiable increase in commercially productive activities in an area, including agricultural, commercial, manufacturing and service activities of a formal and informal nature. The majority of electrification projects currently undertaken in poor and historically neglected areas in South Africa are unlikely to have a significant effect on economic growth in the areas concerned. Nevertheless, the electrification of certain residential areas – for example, some townships and informal settlements in metropolitan and major urban areas – may contribute to a quantifiable increase in commercially productive activities. Electrification projects that form part of broader initiatives to achieve economic growth in poor and historically neglected areas could also qualify for grant funding on this basis. Such initiatives could be: spatial development initiatives, agricultural development projects involving small farmers, and intensive programmes to start and provide support to small, medium and micro-scale enterprises.

The suggested approach is to allocate funds at a national level to planned electrification projects that are expected to contribute significantly to economic growth in poor and historically neglected areas. It is envisaged that the grant funding allocated to such projects would comprise the shortfall between commercial finance and other funding sources, such as concessionary loans, on the one hand and the total costs of the projects on the other. The number of electrification projects that would qualify for funding on this basis in any particular year is expected to be relatively small. It should therefore be possible to process funding applications at a national level. This process will establish the total amount that will be used to support economic growth in a particular year, while the rest of the funds can be used to support socio-economic development in the provinces.

Criteria supporting socio-economic development

The majority of electrification projects are undertaken in residential areas where major spin-offs in terms of economic production are unlikely, although this does not mean that the contribution of electrification to these areas is insignificant. An attempt was made to identify criteria which would ensure that electrification supported socio-economic development most effectively. It is

recommended that a combination of the criteria listed below should be used to establish an index for the allocation of the available funds.

Number of unelectrified facilities providing services in the different provinces

Although the electrification of households is a crucial part of an electrification programme, the emphasis on numbers of connections in the South African programme has meant that the focus has been on households rather than on social services that meet needs in a communal way. The provision of social services such as education, health and water supply, however, is an important aspect of socio-economic development. The number of unelectrified facilities providing social services in the different provinces could be used as an allocation criterion to capture this perspective.

Schools and clinics are the only facilities which have received specific attention in the national electrification programme, with dedicated funding allocated to electrify these facilities. Water supply seems to be the most important public service which has been neglected thus far in the electrification programme, specifically in areas which have been without effective local authorities – that is, most rural areas. This, in spite of the potential that seems to exist for the use of electricity for water pumping.

Targeting specific socio-economic groups

It seems that the only real option for establishing a criterion that reflects the fact that the socio-economic impact of electrification on households and communities can differ substantially, is to give greater priority to certain socio-economic groups in the electrification programme. In order to apply this approach, a number of groups in the population would need to be defined. Furthermore, the percentage of households in the different provinces that fall within each of the groups would need to be assessed, as well as the percentage of these households without electricity.

A decision would further have to be made on the relative importance (weight) to be given to the groups in the electrification programme. One possibility is to treat every province separately, and to allocate most weight to the group with least access to electricity, and least weight to the group with greatest access, in each of the provinces. The weights would therefore probably differ from province to province. This would promote greater social equality in access to electricity among different socio-economic groups in each of the provinces. Another possibility is to give most weight to one particular group throughout the country. For example, 1) communities in metropolitan and other areas where incomes are relatively high; 2) the most impoverished areas which are in greatest need of development (that is, applying the principle of social equity); or 3) the group that does not fall in either of the other two categories, which probably comprises the majority of poor and historically neglected communities.

Poverty levels in the provinces

One of the criteria used by the DBSA to allocate its resources to the different provinces is the poverty levels in the provinces, measured by the 'poverty gap'. Using poverty levels as an allocation criterion would be much simpler than using any of the criteria discussed above. It is not clear, however, whether it is appropriate to use this as a criterion for the allocation of *electrification* subsidies. While poverty levels give an indication of the extent to which provinces require funding to address poverty and support basic socio-economic development, the 'poverty gap' does not contain any specific indication of the extent to which electrification is relevant to the alleviation of poverty in a province.

Numbers of unelectrified houses in the provinces

Both Eskom and the NER use the numbers of unelectrified houses in the provinces as one of their criteria. Its use should have the effect of reducing the inequalities in access to electricity that exist between the provinces. As such it is particularly concerned with political rather than social equality (see above) in access to electricity. However, as with the previous criterion, it presents a fairly easy way of allocating resources to the different provinces.

Other important considerations

The following financial and political considerations need to be included in the allocation process as far as possible.

Average connection costs in the provinces

The average cost per connection varies considerably between the provinces. In order to treat all provinces in an equal manner, the actual costs of extending the grid, whether due to historical or geographical factors or both, need to be factored into the allocation of funds to the different provinces as far as possible.

Political demand for electrification

Local councillors responsible for 'rural' areas may want to continue to provide input to the provincial allocation process even when a national policy has been established. The numbers of unelectrified houses in the provinces, as captured in the 'total needs' index defined by the NER, seem to have been regarded as a fair allocation criterion from this perspective.

Criteria to support project identification

The proposals for criteria for use in operational level planning presented in Banks (1998) fall within a three-stage electrification planning strategy described below. Two options are presented for the core 'difficult' set of decisions.

Criteria for first level decision-making

The first level decision-making process should be a relatively straightforward process of allocating settlements into three broad categories:

- those where *grid* electrification is definitely the preferred option;
- those where *off-grid* technologies are readily identified as being more appropriate (remote, small communities where the cost of grid electrification would be substantially higher than for off-grid electrification);
- and an *uncertain* area for which decisions are not as readily made.

Categorisation into these three areas can be achieved relatively quickly using available data such as settlement size, proximity of households to each other (density), distance between settlements (or if closer to the nearest grid line), coupled with the considerable grid electrification design and costing expertise already gained in South Africa. Where income-related data is available this can be incorporated as an indicator of potential consumption. GIS systems are expected to play a major role in this first pass categorisation process. Additional factors, such as knowledge of related development plans in other sectors, and information on particular site specific opportunities for economic benefit, should be used to modify the preliminary ranking.

Narrowing the 'uncertain band': two approaches and associated criteria

The 'uncertain area' identified in the first stage presents the greatest difficulties, and has been the focus of most attention. From the off-grid point of view, these areas are likely to include the most economically viable projects as settlements tend to be larger, less poor, and closer to existing infrastructure than those in the easily identified 'off-grid' area. Two approaches to reducing the number of settlements allocated to the 'uncertain' category have been identified, the 'grid prioritised' and the 'rational technology' approach.

The 'grid prioritised' approach:

- assumes that grid connection is the strongly preferred option for a variety of reasons (not all readily quantified);
- accepts that economic, financial and social benefits analysis is adequate to prioritise projects which deliver comparable benefits (at least in the first instance); and
- acknowledges that economic analysis is a relatively blunt instrument to rank options that deliver significantly different benefits (that is, that 20 A grid vs. off-grid decisions cannot

easily be made on the basis of techno-economic analysis, particularly in borderline cases).

As a result, off-grid areas are defined primarily a result of carefully prioritised long term grid planning, carried out in the context of a defined financial and institutional grid electrification resource.

The 'rational technology' selection approach assumes that in the more 'uncertain area' cases, a careful technology choice is made, rather than allowing the grid/off-grid decisions to be essentially a by product of a grid planning exercise. This approach requires an accurate social, technical and economic evaluation of grid / off-grid costs and benefits which has a sufficient level of confidence to allow robust grid/off-grid decisions. In order to improve decision-making accuracy, it is recommended that thermal needs (and energy supply options to meet these needs) be included in the evaluation.

Both approaches rely on financial and socio-economic analysis of projects as the principal decision-making tools (either for prioritisation or technology selection). However, in the 'grid prioritised' approach, since one is primarily comparing like with like, there is less need for absolute rather than relative assessment techniques. The 'rational technology' approach requires good attention to allocation of the costs of grid infrastructure development, and to assessment of specific load requirements (particularly of potential productive activities), as these can significantly affect the costs and choice of optimum design for off-grid options.

For both approaches, due attention should be paid to:

- business, productive enterprise and social service electricity requirements (clinics, schools, water supply);
- identifying specific opportunities for extra benefits; and
- an assessment of expected consumption growth on a settlement specific basis.

While the requirement that financial and economic analysis of electrification projects using *settlement-specific data* be carried out as a project selection process may seem onerous:

- software tools are already in existence for grid CBA analysis, and could be adapted to facilitate off-grid project evaluation;
- in many cases decisions can be made without requiring detailed analysis if the option is clearly grid, or clearly off-grid;
- typical project investments are significant, and wise decisions are imperative;
- mistakes are expensive: socially, politically and economically;
- unless settlement specific data on business activity, community facilities, wealth and willingness to pay are determined, electrification planning will continue to be driven by least-capital-cost considerations;
- the availability of data has improved significantly in recent years.

The choice of whether to place primary emphasis on the economic or the financial analysis results derived above (for either approach) will depend primarily on the policy and perspective of decision-makers. If the objective is to utilise the available resources to achieve as wide a coverage as possible, then the financial analysis will be more important. If, on the other hand, maximisation of the national economic benefit is the main concern, the economic internal rate of return (or economic NPV) will carry a greater weight. Both results are important and decision-makers should consider these and other considerations as discussed below.

Adjustments to priorities for grid electrification (grid prioritised approach) should be made on the basis of the following:

1. Settlements which are of significant importance (relative to others) in the region, should be moved up the priority list. These can be identified through the following indicators:
   - settlement size;
   - presence of schools, health facilities, and public administration offices;
   - location with respect to important transportation routes.
2. Settlements that are likely to contribute to, or benefit from, planned regional development initiatives should move up the priority list for electrification.

3. Settlements which have inadequate water supply, or for other reasons are not viable as permanent places of residence, should be moved down the priority list (unless defined plans are in place to improve the situation).

The 'rational technology' approach relies less on relative prioritisation of different settlements against each other, focusing rather on the comparative costs and benefits (financial, economic and social) of different technical options (and levels of supply) for specific settlements. As such, it is more applicable to ad hoc electrification planning, as less emphasis is placed on the generation of long-term grid plans for the entire sub-region.

Both approaches can be used to generate preliminary electrification plans for sub-regions, with budget allocations, and estimated dates of implementation (for the grid projects particularly). It is important that such plans be made public, and opportunity allowed for alteration or changes motivated by communities. This could be through clear and representative redefinition of assumed priorities. Furthermore, decisions and priority could be explicitly changed through communities gaining access to additional funds or other resources and thereby covering a portion of the costs.

Criteria for final project approval

The last set of criteria developed specify a number of conditions which projects should satisfy before the final go-ahead for implementation can be given. In addition to information on the financial and economic analyses referred to above, these criteria would be used to ensure that project participants:

- have an assured demand for the service offered;
- explicitly consider less easily quantified or identified costs and benefits;
- identify and utilise opportunities to maximise the benefits of electrification;
- involve the community in project planning, implementation and operation, where appropriate;
- respect environmentally and culturally sensitive sites and impacts;
- have the necessary technical, financial, project management and community liaison capacity;
- meet quality assurance and technical standards requirements;
- ensure long-term sustainability of service provision (both from a financial perspective), and with respect to maintenance provision);
- have investigated long term grid planning in the project area and incorporated this into the project evaluation.

Conclusion

The intention of this work was to present for discussion a set of recommended criteria to support electrification decision-making. At the time of the research South Africa did not have a clear electrification policy, and it would be a mistake to suggest that our recommendations are an accurate reflection of the still to be finalised electrification policy and strategy. It is far more important that this paper and the detailed reports on which it is based should be seen as a presentation and analysis of issues that could inform and stimulate debate.

References:

Banks, D I. 1998. Criteria to support project identification in the context of integrated grid and off-grid electrification planning.

Banks, D I & Thom, C. 1998. Criteria for integrated grid and off-grid electrification planning. Summary paper.

Thom, C. 1998. Criteria for the allocation of grant funding for electrification to the provinces.

3
Current-limited supplies, supply options and tariffs

Is the 2.5A supply appropriate for rural households?

In the context of high costs of rural electrification with low levels of consumption, providing rural households with a 2.5A current limited supply offers attractive cost savings. As consumption in newly electrified rural households is low, providing an electricity supply as low as 2.5A is considered appropriate by Eskom. Such a decision is based on the assumption that rural households need electricity only for applications such as lighting and media – the need for electricity for thermal applications, such as cooking, is assumed not to be required. With a 2.5A supply of electricity it is possible to use any appliance which does not use more than 560W to operate, effectively meaning that thermal applications are not possible. Although certain appliances, such as irons and kettles, have been adapted to operate with 2.5A, they are not freely available.

While the arguments for implementing current-limited supplies are important from the utility's perspective, it is notably more difficult to determine whether they will be affordable, appropriate and accepted by rural people. Research was undertaken in the 2.5A pilot projects implemented at Tambo in the Eastern Cape and Mafefe in the Northern Province in an attempt to address this issue. Although the project design was not uniform in these areas, the same principles were applied: a flat rate tariff was charged, and the connection fees were different for different levels of supply in an attempt to provide a signal for poor households to select the 2.5A supply.

There are important criteria against which decisions on current-limited supplies should be made. First, it is vital that we consider the position of the very poor and ensure that no electrification strategy exacerbate their poverty and vulnerability. Secondly, systems of payment must enable rural households to have control over their expenditure on electricity. Finally, where specific electricity services are considered to be beneficial and valued by rural people, every effort should be made to deliver them.

Higher-income rural households are able to pay high connection fees

Rural households with relative wealth are clearly not a complicating factor in the discussion on current-limited supplies. Although higher levels of supply are generally required, these households are able to afford and prioritise expenditure on connection fees which are in excess of the standard fee of R75 which is currently charged. Furthermore, as the acquisition of appliances is relatively problem-free, these households are able to enjoy the benefits of electrification. Bearing this in mind, it is important that an electrification strategy does not aim to provide a current-limited supply of electricity only. Current-limited supplies should be provided as one of a range of supply options. It is critical to acknowledge that rural areas, no matter how 'remote' we imagine them to be, are stratified and we need to develop an electrification strategy which accommodates different needs.

The 2.5A supply is a good electrification strategy for the very poor

The position of other households in rural areas is slightly more complicated. First, it is important to consider the case of the very poor. In the face of the struggle to survive, it is unlikely that the very poor will ever be in a position to enact their desires or fulfil their needs with regard to electricity. The 2.5A supply of electricity is a welcome and important service as it provides the opportunity for improved quality of life, at the very least, through the provision of good quality

lighting. However, the research undertaken found that the flat-rate tariff prejudiced very poor people and militated against their sustained use of electricity. In fact, the flat-rate tariff resulted either in households being unable to use their electricity supply or in stress on household budgets. Equally important is the finding that poor households were paying more per month for the same electricity service (for example, lighting) than other households, which were able to pay a higher connection fee for a higher level of supply with a pre-payment meter. Aside from the inherent inequality in this, such a situation can have little impact on improving the conditions of poverty. Furthermore there was a distinct preference for pre-payment meters as they enable people to control their monthly expenditure on electricity. Thus, it is recommended that a 2.5A supply of electricity is supplied with a pre-payment meter.

Some households require electricity for thermal applications

Finally, we need to examine the electricity service needs of rural households which fall between the broad categories of 'very poor' and 'relatively wealthy'. Research has suggested that there are households which are likely to be dissatisfied with what a 2.5A supply of electricity can provide, especially because it does not allow for cooking. From an end-use perspective it seems that the role of electricity in cooking is the critical factor in the decision-making process about current-limited supplies.

It is difficult to quantify the demand for cooking with electricity. There are, however, a range of households which already have hotplates, or are saving for them or desire them. Quantitative analysis has shown that one third of households in rural areas use electricity for cooking, often in conjunction with other fuels and, although electricity is only likely to be used substantially in higher-income rural households, 10% of low-income rural households do use electricity, albeit with other fuels, for cooking. Qualitative research has shown that electricity was used for cooking far more by waged women.

The critical issue with regard to these households is the 20A connection fee. It was found that the connection fee for higher levels of supply at Tambo (20A) and Mafefe (60A) restricted the number of people opting for them. Although most households could not afford the once-off payment for connection, it is quite feasible that households could manage to pay off the connection fee in instalments. There is a strong tradition of hire-purchase payment for furniture, as well as credit from local shops and spazas. Thus, there are two possible options to enabling households to gain access to higher levels of supply:

reduce the connection fee for the 20A supply; the amount of R75 is known and accepted;

charge a higher connection fee of, for example, R200, but allow people to pay the connection fee in instalments over a number of months.

It is important that the cost or method of payment for connection does not force people to select a level of supply which does not provide for all their electricity needs. If a 2.5A is supplied to the very poor, however, it is important that the cost of connection for the 20A is relatively more expensive than the connection fee for 2.5A. This will ensure that those households which will never use electricity for thermal applications will select the 2.5A.

Furthermore, it is imperative that the technical design of electrification projects makes allowance for the need to upgrade. The circumstances and needs of households are not static, and it is essential that, where current-limited supplies are implemented, there is the potential to upgrade – particularly where these limits, such as the 2.5A supply, are very low.

Tariffs and connection fees

It was recommended that policies regarding tariffs and connection fees should adhere to two policy principles, namely affordability and flexibility, as well freedom of choice. Specific policy recommendations included the following:

- A variety of tariffs and connection fees, linked to specific supply levels, should be available to increase affordability and allow a larger range of choice. The price range between the

various connection fees should be relatively small so that people do not feel trapped in a specific choice.

- There should be a relationship between consumption of electricity and expenditure on the service as well as a link between the perceived benefit of electricity and expenditure. A flat-rate payment system was, therefore, indicated as inappropriate.
- The payment system for connection fees should be flexible and users should be in control of their electricity expenditure.
- Adequate and appropriate information should be available to inform choice.

Non-payment

Regarding the issue of non-payment, four policy principles were identified: transparency, flexibility, affordability and consistency.

Specific policy recommendations were as follows:

- Clear, well communicated and flexible procedures regarding disconnection and reconnection procedures should be in place.
- Roles and responsibilities of various stakeholders or role-players should be clearly outlined and communicated to all parties.
- Reconnection fees should be realistic, and not penalise rural people for their poverty.

Level of supply

In terms of the level of supply of electricity to the rural poor, the policy principles of appropriateness and informed choice have been highlighted. Specific policy recommendations include the following:

- The level of supply should be appropriate for rural households (judged by the households themselves) and contribute to the increased quality of life in rural areas.
- Various options should be available, with appropriate measures of upgrading to another level of supply being available to households.
- Adequate and appropriate information should be widely disseminated to enable households to make appropriate choices regarding their required level of supply.

Upgrading requirements

Policy recommendations regarding upgrading requirements should adhere to three policy principles: affordability, effectiveness and transparency. Specific policy recommendations include the following:

- A well managed, transparent system of upgrading to a higher level of supply should be in place.
- Upgrading should be affordable and flexible – for example, the required fee should be payable in instalments.

References:

James, B. 1997. Current limited supplies of electricity in the context of South African rural areas.

Wentzel, M. 1997. Recommendations on electricity supply options for the rural poor.

4
Off-grid issues in rural electrification

Introduction

Off-grid electrification issues were investigated from a number of different angles in the research programme entitled 'The role of electricity in the integrated supply of energy in rural areas'. This paper focuses on issues related to *household* electrification. In the sectoral papers on health, education and water supply which accompany this paper, key findings on the roles, challenges and problems associated with the use of PV and diesel technologies for institutional service support are presented. An overarching issue is that of appropriate choice of technology (grid extension or the use of off-grid options). For the specific sectors, criteria in use are discussed in the above-mentioned papers, while the summary paper on electrification criteria explores electrification decision-making at the community and regional levels in more depth.

Household electrification using off-grid technology

To date, household electrification in South Africa has been dominated by the extension of the grid, with 20A connections being made available to the consumers at relatively low cost at an un-precendented rate (of the order of 450 000 connections per annum). Although some attention has been focused on the use of off-grid electrification technologies by government and industry, only very recently have pilot projects of a significant scale been announced. The experience of large-scale off-grid household electrification delivery in South Africa is thus relatively weak, with opportunities for field-based research on off-grid delivery being consequently rare. Many of the findings listed below, and indeed much current decision-making around off-grid household electrification in South Africa, are thus based on an analysis of scenarios, and 'what ifs'. This in itself highlights the urgent need for active implementation of carefully designed pilot dissemination programmes to gain experience. In the context of this lack of real experience, key findings from three desk-based studies carried out as part of this research programme are presented below.

Davis (1997) investigated the financial and economic implications of different electrification options for two rural settlements. For the tariff and cost structures modelled, the results indicate that solar home systems (SHSs) can be provided at lower life cycle costs per connection than grid connections for more remote communities. For example, off-grid would be cheaper than grid connections for a household demand of less than 50kWh/month (if connected to the grid) and grid extension distance of only 20 m per connection. When the economic benefits of electrification are included, however, the region for which solar systems yield the highest return is restricted to communities further from the grid, principally because the economic benefits of off-grid electrification are less than those from grid electrification. Nevertheless, as is to be expected, off-grid electrification using SHSs is financially and economically preferable for smaller, more remote communities.

Van Horen and Thompson (1998) developed a financial model of the electricity distribution industry and analysed a number of scenarios for electrification of all homes that are currently not electrified. The study showed (as has been done before) that rural electrification in the South African context is not of itself financially viable, without some measure of fiscal or cross subsidy within the industry. However, an important finding was that the net present value of a programme using a mix of service technologies (including two sizes of solar system with monthly tariffs of R15 and R20 respectively) would have a net present value R 9.1 billion (1997 Rands) – less negative than one using only 20A (or higher power) grid connections. The potential saving through the use of a mix of technologies (including solar) is thus highly signficant. The model also explored the viability of an off-grid-only utility, noting that tariff levels would have to be of the order of R36 and R48 per month to cover the costs of delivery and maintenance of small and large solar systems respectively (with a R1500 capital subsidy).

Both the above studies, therefore, suggest that off-grid electrification should form part of the South African electrification programme technology mix, when viewed from a national financial perspective. The picture is, however, not as clear when viewed from the perspective of communities. Off-grid options[1] clearly deliver a far more restricted level of service to households and communities, and may well be more expensive for the householder. Monthly tariffs mooted or being tested on a pilot basis for SHSs are in the range of R18 to R80 (Banks 1998). The same level of service (two to three lights on for a few hours a night and an 80W colour TV) would cost the grid-connected customer only about R8 per month. Furthermore, communities that are electrified using the grid have the option to use electricity for a range of other services including thermal applications and for the development of light industry. Off-grid electrification is thus only likely to be accepted by communities if it is very clear that grid electrification is simply not available to them.

Despite the fact that South Africa has a reasonable PV market, with substantial private sector sales of off-grid household electrification systems (estimated at 3000 to 5000 per year), progress in the development of a large-scale programme has been slow. Constraints and possibilities are discussed below (primarily drawn from Banks (1998)).

Institutional uncertainty: During the period 1996 to 1998 the national locus of responsibility for off-grid electrification delivery has shifted from the Department of Minerals and Energy (DME) to a government-owned company (Refsa), and then back to the DME. This resulted in considerable delays in planned government-led programmes. Both Eskom and the National Electricity Regulator have expressed increasing interest in off-grid electrification, and a number of private sector players have also become more active, some in partnership with Eskom. Although activity is increasing, there is still a measure of institutional flux, and it is difficult for investors to make considered decisions.

Uncertainty around subsidy issues: This is perhaps best illustrated by the significant range in approaches to delivery, and the financing of capital costs evidenced by the few pilot projects that have taken place, or are in the process of being initiated. An early project in Kwa-Zulu/Natal required full capital cost recovery from consumers, through loans of three to four years. Other projects, such as one delivering SHSs to Free State farmworkers and another for the community of Kwa Bhaza, utilise significant capital subsidies. Recent initiatives are considering delivery on a payment-for-service basis, with as yet little clarity from Eskom and government as to whether a capital subsidy will be available or not. The principal arguments in favour of a subsidy for off-grid electrification include:

- Equity: why should those communities not prioritised for grid electrification be denied access to the significant effective cross-subsidy that the grid-electrified communities receive?
- Efficiency of resource allocation: Off-grid electrification is cheaper than grid electrification for remote communities, thus more communities could be electrified, sooner, if some electrification resources are allocated to off-grid areas.

Affordability and willingness to pay: The potential market for off-grid electrification (that is, those households unlikely to be connected to the grid by 2012) is in the range of 1.8 to 3.6 million households (depending on the possible reallocation of grid targets to off-grid electrification). However, as yet there is considerable uncertainty – firstly regarding the costs to customers (subsidies, and finance mechanisms having major impact), and secondly with regard to willingness to pay. Comprehensive surveys on willingness to pay have not been carried out and there is as yet insufficient experience from pilot projects to quantify it. The following table which draws from the summary of experience reported in Banks (1998) gives some indication of the market response to monthly fees.

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[1] Note that the research team focused on SHSs as the primary mode of household electrification using off-grid technology. It is possible that mini-grid networks, possibly powered by hybrid systems, could deliver a higher level of service. These have not been reviewed here.

Area	*Payment*	*Market response*
National commercial sales	R3500 to R4300 either cash or paid over 12 months or less	Estimated 3000 to 5000 systems are currently being sold per year
Maphephethe Pilot project, KwaZulu-Natal	R420 deposit, R80 per month over four years	38 households, 2% of population in district
Eastern Cape interview based research	R73 deposit, R 48 per month	Stated willingness to pay for SHS of 'low income band' in community
KwaBaza Energisation pilot project	R140 deposit, R 30 per month	70 households signed up, size of customer pool not known
Interview based research, Eastern Cape and Kwa-Zulu/Natal (1996)	R 20 to R30 (for low income groups)	Monthly expenditure on lighting and media fuels (that could be replaced by SHS)
Expenditure on grid electricity by households	R24	Approximate amount that electrification programme customers spend on grid electricity (80 kWh/month)
Consumer surplus	R20	Willingness to pay estimated by Davis (1997) using consumer surplus approach

Maintenance and running costs of off-grid electrification: Although off-grid electrification systems require relatively little maintenance, batteries and lights will have to be replaced (probably about once every three to four years). International and local experience indicates that maintenance costs can be extremely significant (with a twenty-year NPV of the order of 70% of the capital costs), and potentially beyond the means of low-income customers. If a commitment to maintenance is not adequately built into programme design there is a real risk of substantial failure a few years after programme start.

Delivery mechanisms: A number of different approaches to delivery and cost recovery have been adopted in existing and planned pilot projects. For those that aim to recover a portion or all of the capital costs, two principal mechanisms have been proposed: either a direct sale of the systems using a hire-purchase-type agreement, or a 'utility' approach in which the service provider retains ownership of the PV module, battery and charge controller, and the customer pays a monthly tariff (as for grid-based electricity supply, except that the tariff would use days rather than kWh as the unit of measurement). The former approach places far more responsibility on the customer, with the long-term risk for the supplier being limited to the loan period. Customers also take a greater risk, in that they may be saddled with an unwanted asset (or liability) if their circumstances change or even if the community is electrified. The utility approach will place a greater share of responsibility for maintenance and risk on the part of the service provider, as customers can choose to stop payment at any stage with little loss of investment. The utility approach also has the promise of lower initial monthly fees (although longer-term costs would be higher).

Complementary energy services: As noted above, the energy service offered by off-grid electrification is restricted. The Energisation approach being piloted by Eskom and the LPG Association at present in KwaBaza involves the provision of gas or other energy supply options in parallel with SHS electrification. While this specific approach adopted in this pilot may not be ideal (it lacks flexibility in that gas supply and PV system are sold only as a combined package), an integrated approach to rural energy service delivery (rather than electricity delivery) is a welcome development.

Uncertainty regarding grid electrification plans: Both communities and supply institutions are wisely reluctant to invest in off-grid electrification if there is any chance of receiving grid electrification. Negotiations with potential pilot project communities have highlighted uncertainty (and high expectation of receiving grid) as one of the key constraints to off-grid electrification delivery. There is an urgent need for reliable, consistent medium to long term electrification planning to be carried out and for the results to be publicised. The issue is discussed in more detail in the summary paper on electrification criteria.

Conclusion

South Africa stands on the brink of a possibly rapid and important expansion of off-grid electrification. It is critical that projects implemented are sustainable in the long term, or the waste of resources, cost to communities and the loss of credibility will be enormous. As with other off-grid electrification programmes (schools and clinics) there is a real risk that two vital areas may be inadequately addressed: customer acceptance, and longer-term maintenance. The former will require excellent community negotiation, and presentation of accurate information to customers, especially about grid electrification plans. There will be a need to respect the judgement and wishes of rural communities, especially if national subsidies are included in the programme. Effective maintenance will rest on the long-term establishment of a solid technical skills base in or close to communities, and a commitment to support from service providers on the one hand, and satisfied, informed and empowered customers on the other.

References:

Banks, D I. 1998. Off-grid electrification for the poor: constraints and possibilities.

Van Horen, C & Thompson B. 1998. Sustainable financing of electrification in South Africa.

Davis, M. 1997. A financial and economic analysis of two electrification projects.

- Rural people should be enabled (through the process described in the previous two points) to make informed choices about their electricity supply, particularly in the context where different levels of supply (20A and 2.5A) are provided.
- Evaluation and self-reflection of work with communities should be established in the normal practice of staff working with communities.

Encouraging these shifts within Eskom might be an appropriate interim arrangement, as it would result in improvements in activities (such as user education and information dissemination) for which Eskom is currently responsible. It is our opinion, however, that Eskom is not best placed to fulfil these functions, largely because its organisational structure and culture supports the delivery of a technical good together with marketing and selling this good. It is also likely that the restructured regional distribution agencies (REDs) will have similar organisational structures and cultures, thus making it difficult for them to adopt a participatory approach to working with communities. For this reason it is recommended that these functions are sub-contracted to organisations and institutions with the requisite skills to build human capacity in the delivery of electricity. There are two possible, but not mutually exclusive, options: first, in the restructuring of the EDI, parallel organisations which are attached to the distributor could be established, with the explicit function of providing an interface between communities and the REDs; and, secondly, these functions could be sub-contracted to NGOs.

By removing these functions from the distribution agency, there is more potential to implement some of the strategies within a framework of participatory development, where investment in human development is prioritised. In the context of rural electrification in South Africa, partnerships with rural communities would be developed so that decisions could be made jointly. The social analysis and research which must necessarily inform the technical delivery would be undertaken by this organisation together with the community. Eskom (or its future equivalent) would continue to provide information on electrification planning, project design, tariffs, use and safety. The community facilitation agency would facilitate the process of dissemination of this information. Eskom would continue to market and sell its electricity, as well as provide an appropriate customer service. In this way, rural communities will be better placed to negotiate with the electricity distribution agency, to make informed choices and to shape the outcome of electrification projects. Also, separating these functions from the electricity utility would mean more scope for providing an education and information dissemination service to rural communities which extended beyond electricity to include all other energy issues.

The restructuring of the EDI offers an opportunity to assert the importance of creating REDs, with supporting sub-contractors (both technical and social) which can support improved practice. For this to happen, thought must be given to the organisational culture, form and roles of the REDs. While REDs should not undertake this work, it is critical that resources are allocated towards this end. For this reason, it is essential that the debate about the way in which electrification is delivered is placed within the public policy arena. If it is considered an operational issue, to be shaped by Eskom or the REDs, it is unlikely that we will see any changes in practice.

Reference:
James, B 1998. Community participation in rural electrification: Building human capacity through the delivery of electricity to rural areas.

6
Community-based organisations for operation, maintenance and administration in rural electrification

The experience in South Africa

Within the broad context of rural development, community-based organisations (CBOs) are perceived as the elixir to ensure sustainability and empowerment. Projects justify the development of such organisations because of benefits ranging from cost reduction to community participation. Within a rural electrification programme there are potential gains associated with devolving certain functions, such as operation, maintenance and administration, to CBOs, but in South Africa there is relatively little experience of establishing CBOs to fulfil these functions in the electrification programme. Where some of these functions have been devolved to local communities in the South African electrification programme, the main reason for this has been to save costs. Two types of CBO have been established by Eskom: the first and more common arrangement has been the devolution of certain operation, maintenance and administration functions – most notably revenue collection and management, to *vending agents*. The second type of CBO, *electricity agencies,* have been established in both solar and 2.5A current-limited supply electrification pilot projects, and have seen more functions being devolved, including revenue collection and management, maintenance, disconnections and new connections, user education, and marketing and promotion of electricity.

Lessons from the experience

One of the main problems facing Eskom is ensuring the financial accountability of local vending agents and electricity agencies. Vending agents roll over (or 'borrow') money and end up in debt. Part of the problem is that the systems to support financial accountability have not been well established. Another problem is that there are too few Eskom staff members to supervise the vendors. In the Northern Province, there has also been a large staff turnover, making it difficult to establish good relationships with vendors.

The Mafefe Electricity Agency, established in one of the 2.5A current-limited supply projects, has been criticised as not being established in a transparent manner, as lacking legitimacy in the community, and as almost impossible to 'keep' accountable. Research found that there was virtually no knowledge amongst people generally of the Electricity Agency that was to be established in Mafefe. There was little participation in defining the nature of the organisation, how it would relate to other organisations or what roles and functions it would play. As a result, power struggles in the community were exacerbated and it has proved difficult to ensure accountability.

A number of problems with the quality of service provided by the electricity agencies have arisen, mostly as a result of poor communication between Eskom, the agencies and community members. Problems have been experienced with the quality of service given by the vending agents. As people are generally appointed on the basis of their business skills they are not necessarily equipped to deal with customer complaints and queries. Furthermore, it was found that training of the electricity agency members had not occurred.

Establishing sustainable CBO

Sustainability versus self-sustaining

Perhaps the most important insight to inform this work is that the concept of sustainability of CBOs does not mean that they are self-sustaining. In other words, external inputs are essential to effective operation of CBO. This means that effort should be made to define the types of interaction and assistance which is required for long-term viability, rather than being concerned with how to enable community-based organisation to operate without any external inputs. Eskom, or any future electricity utility, cannot absolve itself from responsibility for ensuring that an agent is able to fulfil his/her responsibilities as support and supervision are essential: regular meetings, appropriate accounting systems, regular reconciliation of the books and revenue collected and training of the agent should be facilitated.

Building the capacity of CBOs

Training of CBO members is an important component of the support required of the external agency. Where capacity-building has not occurred it has been found that the organisations do not survive. Developing and strengthening the capacity of people in CBO cannot be achieved through the application of blueprint formulas. Needs will differ from one community to the next – both the content and approach to building capacity should be dictated by local needs. The types of training include leadership, management, technical (including tariffs), financial (including banking practices), as well as constituting and running committees.

External mechanisms for accountability

Due to the difficulties in ensuring the financial accountability of agencies, it is essential that procedural mechanisms for revenue control, supervision and credit control are put in place and supervised. In rural areas, especially those far from urban areas with their banking systems and tarred roads, it may be more difficult to implement such systems of control. However, ensuring that vending agents use appropriate financial accounting systems, are able to bank money regularly, and are visited regularly by Eskom staff seem to be the basic requisites for maintaining financial accountability.

Supporting utility staff

There is a need for committed staff, who are themselves trained, supported and managed, to support community-based agents. Eskom has found that it is important to source Eskom staff who are to manage, supervise, support and train vending agents and other CBOs from the communities in which they will work. Further, it was emphasised that where these Eskom staff enjoyed political credibility, negotiations and difficulties were more easily resolved. However, Eskom staff members who live in communities where Eskom has electrified often suffer from burnout due to the demands placed on them by community members. In order to support this level of customer service, the staff members are encouraged to take leave whenever they need it.

Possible roles and functions

In South Africa the main experience has been with the devolution of the revenue collection function to CBOs or individuals. The devolution of other customer service functions, such as meter readings, billing, information dissemination and dealing with customer complaints and queries is also possible. There is also great potential to train local CBOs to educate people about the safe and efficient use of electricity.

There seems to be consensus about not devolving the role of disconnecting non-paying customers to local agents. In some cases, where agents do the physical disconnection, they are not responsible for making the decision about which households will be cut off. There is a great potential for this function to become subsumed in broader power struggles.

With the exception of low voltage maintenance functions, maintenance of grid electricity systems is also not considered a viable function to devolve to a local agent, mainly because the

electricity environment is dangerous – Eskom remains legally responsible for the safety of its sub-contractors. On the other hand, off grid-electricity maintenance is considered to be an essential function of CBOs or individuals. Without this it is unlikely that off-grid programmes will be sustainable.

Local conditions inform type of organisation

Another significant lesson from the South African experience is that it is important for the local conditions to inform the exact form of any community-based agency which is being set up, as it has been found that the most effective and sustainable organisations were those that were adapted to local conditions and which did not impose a blueprint organisational design. This does not mean that it is not possible to have some consistency of rules.

Community mechanisms to ensure accountability

There are a number of ways in which communities can be involved in keeping CBOs accountable. It is not sufficient just to involve communities in elections. Constituting a higher decision-making authority, such as an annual general meeting or a board, are ways of involving community members. Although important, it is also clear that these mechanisms do not necessarily *guarantee* that the organisation will be accountable. Success largely depends on the capacity of community members to participate actively in this task. Establishing transparent rules and providing sufficient and appropriate information will assist in this task.

Incentives to participate

The provision of incentives to participate in CBOs was observed to be important in the long-run sustainability of these organisations, as people participate on the basis of gains and benefits. In other sectors, such as the provision of water to rural areas, cash incentives have been used to stimulate the efficacy of CBOs. Volunteer positions often place a burden on people as the responsibilities, time and effort outweighed the benefits of being involved.

Power relations within CBOs

Communities are not homogenous: social relations of power, such as gender and class, differentiate community members and CBOs usually reproduce social stratifications in the community, with positions of power likely to be occupied by wealthier, more powerful individuals (usually men). While it is important to include marginal groups, such as women and poorer people, capacity-building strategies to ensure that they are able to contribute equally with other CBO members must also be put in place.

Implications for the electricity utility

One of the major implications of building CBOs is that fieldstaff have to become facilitators and organisers, work which is traditionally associated with unions and NGOs. To institute a practice which will build the capacity of CBOs to fulfil operation and administrative functions in rural communities is a difficult task for an electricity utility due to its organisational culture and form. We recommend that the electricity utility does not constitute *electricity agencies,* which devolve a wide range of functions, but that it subcontracts these functions to an organisation, such as an NGO, which has the organisational culture and skills to support CBOs. The utility would retain its marketing function and controls over revenue collection.

However, there does seem to be the possibility of continuing to establish and improve the sustainability, accountability and efficacy of *vending agents.* It is worthwhile stressing that the restructuring of the electricity distribution industry offers an opportunity to shift the practice of the technical delivery of electricity to prioritise and resource an investment in human development, through improving the approach to delivery as well as emphasising the need to build the capacity of rural people.

Improving the revenue management system

Eskom is incurring substantial losses through theft, fraud and debt. In addition, itincurs high ad hoc costs associated with training and retraining of new and existing vending agents. Other costs incurred include technological losses and maintenance costs associated with inadequate training of vending agents, and legal costs associated with attempts to recover stolen or borrowed revenue. The table below outlines these costs for 1997 in the Pietersburg administrative region.

	Cost (R)
Losses through theft, fraud and debt	112 400
Training new and retraining existing vending agents	19 915
Technological losses and maintenance costs	6 000
Legal costs	10 000
TOTAL	**148 315**

Experiences in the Lydenburg and other SACS offices have shown that, through a combination of ongoing support and supervision, rewards and controls, the losses and ad hoc costs in revenue management can be substantially reduced and even eliminated. The actions which should be undertaken to improve the revenue management system are outlined below.

Establish an Eskom presence

One way in which Eskom attempts to keep the vending agents financially accountable is through establishing a regular presence –primarily through regular visits by vending agent controllers and security personnel, but also, in some cases, through hands-on management. For example, in the Lydenburg administrative office, the senior officer gets actively involved where agents are suspected of short banking, adding authority to the issue. As a counter-balance, the senior officer also sends letters of affirmation to vending agents who are performing well.

Reduce the lag time

Losses can be reduced by limiting the lag-time between sales, revenue collection, banking and reconciliation. Having a short lag period not only enables Eskom to identify and follow-up short banking promptly, thus increasing the chances to recover shortfalls, but also reduces the risks of vending agents rolling over money and getting in to debt. The systems required to reduce the lag time are daily collection and banking of revenue, prompt and accurate reconciliation of sales and revenue, and immediate follow-up of suspected theft or debt.

Daily collection and banking of revenue

The daily collection and banking of revenue by revenue collection agencies reduces the opportunity for vending agents to steal or borrow revenue by minimising the amount of money held by them at any one time and creating a physical security presence. The additional costs associated with daily collection of money is small – only R146.00 per agent per month – but it has substantial benefits in terms of reducing losses from theft, fraud and debt; legal costs of recovering money; and cost of appointing and retraining new vending agents.

Prompt and accurate reconciliation of sales and revenue

To reduce risk and maintain control, Eskom needs to keep administration up to date. The quicker Eskom identifies and follows up debts, the more likely it is to recover the money. The more timely the payments are to the vending agents, the less likely the vending agents are to roll over money and get into debt. The established Eskom standard for accurate and timely reconciliation is a maximum of 15 reconciliations per senior clerk, and experience in the field corroborates this standard for efficient and effective reconciliation. At present, with 87 and 47 vending stations in the Pietersburg and Lydenburg administrative areas respectively, three more senior clerks are required at the Pietersburg office and one more at the Lydenburg office. This

translates into an additional operational cost of approximately R150 000 and R50 000 per annum in the Pietersburg and Lydenburg offices respectively. While the costs of reconciliation are substantially reduced when applying this standard, the efficient functioning of reconciliation will eliminate the costs of temporary staff (R15 000 in Pietersburg), reduce the errors in reconciliation, thereby encouraging trust between agents and Eskom and reducing losses associated with debt and theft by vending agents, legal services required to recover losses and cost of appointing and training new vending agents.

Immediate follow-up

With the reduced lag time, Eskom is able to act immediately if any problems arise. For example, if an agent rolls over money, Eskom can prevent the agent from getting into debt which he/she cannot repay. While there is a need to act quickly, this must be balanced with caution. For example, in the Lydenburg administrative area, one agent is suing Eskom for R100 000 for accusing him of theft. Suspected theft must be closely investigated and discussed with the agent. Vending agents must be adequately warned and decisive action must be taken if problems continue to arise.

Provide adequate support and training

Eskom must provide ongoing support and training to vending agents. In some areas vending agents are considered to be self-sufficient once they have received initial training and any further support and training provided occurs in an ad hoc and reactive manner; in others, for example the Lydenburg administrative area, emphasis is placed on ongoing training and support. Vending agents are invited to formal workshops twice a year where they are provided with refresher training, introduced to new concepts and issues, and invited to share their concerns. The experiences in the Lydenburg administrative region clearly show that formalised ongoing training has a positive impact on the losses incurred by Eskom. Comparing the costs associated with the provision of training in the Pietersburg and Lydenburg administrative areas shows that the difference in costs incurred by Eskom for education and training of vending agents is small, amounting to between R93.00 and R173.00 per vending agent, while the avoided ad hoc training costs are between R223.00 and R235.00 per vending agent. Investment in initial and ongoing training thus has a net benefit for Eskom.

Provide adequate remuneration

The current structure of the vending agents' remuneration package creates a strong link between total monthly income and sales. As the basic salary shrinks (from R300.00 to R250.00 in the Lydenburg administrative area), the dependence of vending agents on commission from sales increases. In more remote areas, where the customer base is small, vending agents may receive a net income of as little as R275.00 per month. In such cases, where the vending function is undervalued and insufficiently rewarded. Eskom cannot expect vending agents to be loyal to them if they are provided with insufficient incentive to fulfil their contractual obligations to Eskom. The remuneration package offered to vending agents must be adequate to encourage commitment to vending as a business enterprise. The level of remuneration should take into account the responsibilities of the agent and the skills required and should value this service appropriately, as well as what income is required to adequately support the vendor. This can be established through a 'basket of goods' approach which identifies the needs of the vending agent.

References:

James, B. 1998. Community participation in rural electrification: Community-based organisations for operation, maintenance and administration in rural electrification.

Simmonds, G. 1998. Revenue management in rural electrification: Administrative and operational costs of community-based organisations.

7
Electricity and domestic water supply

It is estimated that 18 million South Africans are currently without access to safe and adequate potable water supply. The lack of access is heavily biased towards the rural areas, where approximately two thirds of people experience a sub-standard water supply, with African households suffering most: 74% of households need to fetch water on a daily basis, 21% of which have to cart water over distances greater than 500m from the household – thereby reducing per capita consumption levels considerably.

Since the 1994 elections the co-ordinated efforts of NGOs and government have brought good water supplies to well over one million rural people. The majority of these beneficiaries, however, live in settlements larger than 10 000 people. The bulk of the task to bring water to all is thus still outstanding and it is expected that the size of community water supply schemes will become progressively smaller as the government's policy goals are met.

Role of energy/electricity in domestic water supply

Electricity from the grid and from photovoltaic (PV) panels, as well as direct-drive diesel pumping (generally not electric), may all be appropriate pumping power supply options. Grid powered pumping is generally considered the most versatile, reliable and maintenance free, and often also the most cost effective (depending on the required grid extension distance).

Bulk regional water supply schemes typically serving 20 000 to 30 000 people are undertaken by the Department of Water Affairs and Forestry (DWAF), which insists on the use of grid electricity in these cases because of the high reliability and cost-effectiveness of the supply. If the grid is not available in the areas where bulk water supply schemes are implemented, DWAF funds the extension of the grid to these areas.

Grid electricity is also the preferred energy option for stand-alone water schemes (as opposed to regional schemes) undertaken by DWAF, typically serving more than 5 000 people. Stand-alone water schemes comprise the majority of rural water supply schemes undertaken with RDP funds. In these cases grid electricity is only used if it is already available in the area concerned, or if Eskom plans to electrify the area while the water project is being implemented.

While there are many instances where grid electricity is used for water pumping in DWAF water schemes, it is unlikely that the potential is being fully realised. It has been estimated that there are about 1 350 rural communities with a population of at least 4 000 which are currently without adequate water supply (about 13% of the 10 800 communities without adequate supply nationally). It is unlikely that all of these communities could be electrified with the grid, but this gives some indication of the potential role of grid electricity in water pumping amongst larger communities.

Another potential role for grid electricity in water pumping is the replacement of diesel pumps with electrical pumps in communities which are electrified, or are being electrified. Diesel has been the most popular choice for smaller stand-alone community water schemes for many years. They have always been the choice of DWAF and were initially the preference of other NGOs in the water sector, such as the Mvula Trust. Diesel is usually most economical for communities of 2 000 to around 10 000 people. Depending on the particulars of the community diesel may also be appropriate for those of under 2 000. Once a diesel system is serving more than 10 000 people it becomes difficult and expensive to manage.

DWAF currently has a policy of only using diesel where non-grid power is required for water pumping. However, DWAF is funding a two-year research project to examine the viability of solar pumping on South African rural water supply schemes. Water systems need to be as affordable as possible for communities. International experience seems to indicate that the operation and maintenance (O&M) costs of PV systems can be lower than diesel for

communities of around 1 000-2 000 people, each receiving 25l/day. Almost half of the total number of rural communities with a water need have populations of less than one thousand, while 70% of all rural communities with a water need comprise 2 000 or fewer people. The potential market for solar water pumping therefore seems very large.

The Mvula Trust has found that community-managed water supply has a better chance of success in communities of 2 000-5 000 people. However, the minimum O&M requirements are often beyond the meagre financial means of these communities, particularly where diesel is the only source of energy available, thus leading to premature failure of water schemes. Because of this, the Trust is also looking towards solar power to provide a cheaper option in terms of communities' O&M costs.

If PV water pumping systems are to be successful it is vital that they be properly installed and that back-up service be available, within a reasonable distance. Regular maintenance visits would also be ideal.

Limitations and benefits of energy supply options for rural water supply

Source	*Benefits*	*Limitations*
Diesel	Most economical with certain community size, generally greater than 2 000 people. Parts and expertise widely available, even in remote areas. High community acceptance. Generally able to cope with upgrades in levels of service.	High operating and maintenance costs of fuel, including transport and the time taken to deliver. Shorter life span than PV systems. Cost recovery and sustainability reliant on strong local institutions. A skilled pump operator is necessary.
Solar	Most economical with certain community sizes, generally less than 2 000 people. Generally longer life-span than diesel. Requires less community involvement in operation and maintenance. Does not require fuel or pump operator.	Risk of panel theft. High capital costs Back up service and maintenance not currently available in remote parts of the country. Cost recovery reliant on strong local institutions and innovative finance.
Grid electricity	Most reliable supply. Requires no community maintenance. Upgrades are no problem. There are strong institutions such as Eskom and DWAF able to take care of cost recovery.	If area is not being electrified in future, the extension of the grid is unaffordable for most rural communities. There must be a creditworthy party willing to enter into a contract with Eskom.

Cooperation between DWAF and Eskom

The level of contact between DWAF and Eskom varies in different areas, but is, on the whole, low. At the national level there has been little substantive contact in the past. Interaction has occurred, but on an ad-hoc basis. In the regions there has been some contact through provincial development forums. Through these forums Eskom and DWAF learn of each other's broad plans. It appears, however, that the information presented is insufficient for local planning and interaction.

The Eastern Cape seems to be the only exception to the general situation. In the Eastern Cape there is contact between Eskom and DWAF, which began when DWAF approached Eskom for information on setting their delivery plans for a European Union-funded programme to see if there might be overlaps in supply. According to the Electrification Manager in the Eastern Cape, Eskom includes the potential electricity usage of water pumps in the villages in the cost-benefit analysis undertaken when prioritising areas. One borehole pump for a community of around 200 households may not be the make-or-break factor as to whether a community gets electricity, but will generally increase the viability of a proposed project.

There are opportunities for both DWAF and Eskom to benefit from greater cooperation. For example, opportunities exist for sharing the costs of grid extension to rural communities. Both organisations have some funds for subsidising service delivery, while there are geographical overlaps in their delivery areas, and correspondence between their objectives. If DWAF carries the costs of a minimum capacity line into an area to pump water, villages that were previously not viable for Eskom electrification might become so. An example of such cooperation between DWAF and Eskom exists in Mpumalanga.

There seems to be scope for Eskom to be more proactive in influencing the energy sources used for rural water supply. For example, in situations where Eskom supplies electricity to a rural community which has an existing diesel-powered water pump, they should give consideration to converting the pump to grid electricity. This way the community would get a more reliable and cheaper water pumping system and Eskom would get better utilisation and cost-recovery of its infrastructure. Opportunities to convert non-grid systems to grid should be communicated to DWAF as they arise. Together, the two organisations should also consider establishing a long-term cost-benefit procedure, which incorporates water supply reliability, for the replacement of diesel pumps with electrical pumps.

The two organisations also need to share their long-term plans in order to make cooperation more effective. The following are suggested mechanisms for cooperation:

- Eskom and DWAF head offices need to establish a joint policy regarding cooperation between their local/regional staff, and encourage its implementation.
- Coordination should primarily take place on a project level. It should focus on very practical, project-specific ways in which the two organisations can work together.
- Simple steps should be introduced into the routines of sub-regional planning staff, such as half-yearly meetings which could involve each service provider presenting their plans for the next year to each other. Overlaps in delivery could then be examined for areas where there is potential to cooperate. This should be coupled with regular semi-formal meetings on specific local plans and projects, which are of great importance as plans can change within a short period of time.
- The Provincial Planning Forums should still be used by DWAF and Eskom to reinforce coordination and ensure the smooth flow of information.

Recommended roles of institutions

Department of Water Affairs and Forestry

- Standard methods should be employed by all water service providers for the calculation of comparative life-cycle costs for water supply systems, regardless of the nature of the energy supply. With its significant experience in this area, DWAF should lead a process to develop an agree methodology for the sector.
- DWAF should investigate applying the BOTT (Build Operate Train Transfer) approach for the delivery of PVP systems to a group of communities in an area.
- DWAF should ensure that all engineers receive training and information on PVP systems and that they are able to adequately convey to communities information about how PVP works and the benefits it offers. DWAF should liaise with the Department of Minerals and Energy (DME) to collect and disseminate the necessary up-to-date information on PV technology.
- Means of providing support networks for PV pumping systems need to be established. For example, the possibility of cost-sharing arrangements with Telkom for dedicated emergency lines could be explored.

Department of Minerals and Energy

- The DME should be the lead agent for the establishment of a financing system to promote the use of renewable energy for rural water supply projects. For example, an application

could be made to the Global Environmental Facility with the support of Eskom, DWAF and the PV industry.

- DWAF and DME should jointly co-ordinate the provision of independently researched information about the capacity, life and operation and maintenance costs of different energy options for rural water supply, to players in the water sector.
- The DME should insist that Eskom clearly demarcate the areas to which it will not deliver grid electricity in the next five years. This information needs to be supplied to all PVP and water service providers, following which DME and DWAF could consider issuing PVP concessions to the private sector in selected areas.

Eskom

- Eskom needs to clearly demarcate the areas to which it will not deliver grid electricity in the next five years. This information should be supplied to all photovoltaic pumping (PVP) and water service providers.
- Eskom needs to be more proactive in influencing the energy sources used for rural water supply. In many instances grid is marginally competitive from a cost perspective, and Eskom should be identifying all potentially viable markets and clients systematically, as they expand the grid into rural areas. Furthermore, in situations where Eskom supplies electricity to a rural community which has an existing diesel-powered water pump, they should give consideration to converting the pump to grid electricity.

Reference:

Development Planning & Research. 1998. Electrification and rural water supply.

8
Electricity and small-scale agriculture

Potential role of electricity in small-scale agricultural development

Electricity has an important and irreplaceable role to play in small-scale agricultural development in South Africa. While electricity does not of itself generate agricultural development, under the right conditions it can greatly increase agricultural productivity, and create possibilities for value-adding activities. The necessary agricultural policy framework to ensure that electricity will play a successful role in small-scale agriculture is in place in South Africa. Institutional responsibilities are clear, and the necessary supporting structures are there, although capacity is not always strong at the different levels. Public sector funding of agriculture, primarily through the Land Bank, has been transformed to allow innovative financing in the absence of physical collateral. Although the transformation process is still in progress, considerable progress has been made in directing public sector support to small-scale and resource-poor farmers.

Furthermore, there are many small-scale agricultural projects which meet a range of conditions that are regarded as prerequisites for the electrification to impact significantly on agricultural development. These include access to profitable markets, access to land, access to the basic inputs which support any agricultural enterprise, and the necessary skills to utilise the available inputs.

Two broad categories of such projects have been identified: 'less formal' and 'more formal' projects. The less formal projects are usually small, depend on local consumption or markets and are institutionally simple, based on either households or small groups. They typically involve vegetable gardens, small-scale pig and poultry enterprises and water-pumping for cattle watering. The power consumption, whether for pumping, cooling or heating, would usually be less than 1 kW. The value of the output is often high – for example, vegetables produced either for home consumption or for sale. Many of the characteristics of projects in this category make them candidates for diesel or solar power. It is of interest that it is in this less formal category that Agrelek seeks to expand its client base.

The more formal projects typically produce for distant markets and, often, for export. They are institutionally complex, involving collectives of growers managing a single scheme, which supports their own individual enterprise. Schemes producing sugar cane, cotton, citrus and other cash crops are typical. Power consumption varies greatly with circumstances, but installations drawing from 50–250 kW are common. The need for substantial funding and the installation of large-scale infrastructure means that support from the public sector is essential. For reasons of cost and complexity of operation, there is no practical alternative to grid electricity for these schemes. It does not appear that Agrelek pursues opportunities as vigorously in this category as it does in the commercial sector, probably because of the perceived administrative complexity. This category does, however, present the greatest opportunities to expand consumption in small-scale agriculture.

It is therefore recommended that schemes involving collectives of small growers be given more attention by Eskom (Tapson 1998). There are existing cases where electricity is the main outstanding requirement for such larger-scale irrigation projects to proceed. There is an unsatisfied demand present, therefore, while opportunities exist where marginal extensions or diversions of the grid expansion could bring valuable agricultural resources into productivity.

Best estimates indicate that the total area of potential arable land available in South Africa is some 15.9 million hectares, or 13% of the total surface area. Almost all of this land is already used. Some 1.3 million hectares, or 8.2% of the total potential arable land, is irrigated. This 8.2% provides between 25% and 30% of total agricultural output These figures illustrate two

crucial characteristics of agriculture. First, the agricultural economy is built on a very narrow resource base, with very little left for horizontal expansion. This points to the high value which can be imputed to the remaining development potential. What land is left underutilised lies mostly in the former homelands, which is where the opportunities to develop in the future will be found. Secondly, the fact that 8.2% of the total arable land which is under irrigation produces 25 to 30% of the total agricultural output illustrates the value which irrigation imparts to the land and, therefore, the importance of electricity in supporting irrigation development (Tapson 1998).

Energy supply options for small-scale agricultural projects

Three energy sources were considered in the analysis: grid electricity, diesel and photovoltaics. Grid electricity has the advantage of being a mature and universal technology, with well-developed end-user technology and delivery systems and is, within the constraints of the extent of the grid, the cheapest of available sources. In developing areas, the technical and economic advantages of grid electricity are considerably reinforced by the fact that only rudimentary institutions are needed to ensure its sustainable delivery. The other options require robust and sustainable institutions in order to be effective. By virtue of electricity's cheapness, agriculture based on the use of other energy sources has effectively been rendered uncompetitive.

Diesel is characterised by being more expensive than grid electricity – it is estimated that, for irrigation purposes, as much as four times more. Greater skills are required to maintain and operate the plant, and robust institutional capacity is needed to ensure that supplies of fuel are on hand when needed.

Photovoltaic (PV) systems are characterised by high initial costs and very low running costs, which makes them favourable where welfare demands are high and grant funds can be justified. For applications such as refrigeration, pumping and small tools they are particularly efficient. On a life-cycle basis they are cheaper than diesel and grid electricity where, for example, the link to the grid exceeds two kilometres in length, and more than 10 kWh per day is required. PV systems have the peculiar advantage of being scale-neutral in terms of costs – small installations can be as cost-effective as larger ones, which is not true for either of the alternatives. This is particularly important for small-scale agriculture. If carefully matched to end-user technology, they are efficient and economic for a range of light load functions. They have the disadvantage of being vulnerable to vandalism and theft, however.

Cooperation between Eskom and provincial Departments of Agriculture

In neither the Eastern Cape nor KwaZulu-Natal was there any evidence of regular contact between Eskom and the provincial Department of Agriculture at strategic level, or in fact, of much contact at all (Tapson). The result of this weak liaison is that opportunities to expand consumption of electricity and contribute to expanding small-scale agriculture are missed. For example, minor re-routing of Eskom lines would make it possible to bring into production areas of high agricultural potential. It appears that Eskom does not routinely factor agricultural potential into its decision criteria when planning the extensions of the domestic systems.

Nevertheless, there is significant collaboration between the staff of Agrelek's S&MSF (small and medium scale farmers) initiative, and officials of the Departments of Agriculture regarding the planning and evaluation of new projects. Agrelek makes use of specialist agricultural staff – for example, departmental economists provide the feasibility studies for the projects to which Agrelek intend to supply electricity – and the departments in turn contact Agrelek when new small projects may arise. However, Agrelek has little involvement in the planning of the electrification programme. There seems to be some frustration among Agrelek staff regarding the current electrification planning process.

Tapson makes the following three recommendations regarding future collaboration between Eskom and the Departments of Agriculture:

- *No new electricity coordinating structures.* There are a plethora of coordinating or integrating forums in the rural field, including agricultural forums and local government, and many of these stagnate because of the high pressure on the people involved. For this reason, a further coordinating forum for energy or electrification in agriculture is not recommended. Furthermore, the appropriate bodies to plan and implement both agricultural and electricity development are in place – the Departments of Agriculture and Eskom respectively – and no other institution can rightfully claim ownership of these processes. What is missing is a necessary level of contact between these organisations, which can be achieved without setting up coordinating overseers, if the intention to collaborate is present.
- *Liaison at a strategic planning level.* The provincial Departments of Agriculture should pro-actively seek the collaboration of Eskom at the level of strategic planning. This does not mean periodic contact at the personal level between individuals of the two organisations. Rather, Eskom should identify a key planning staff member who is delegated to attend all development planning meetings of the Departments, as a formal committee member. The benefits for both would be substantial, mostly from the systematic and formal exchange of information. Knowledge of the priorities of the Departments would enrich Eskom's planning process, while forewarning of where Eskom's grid extensions are to be sited would assist the Departments in preparing its public sector investment programme.
- *Information sharing.* A specific outcome of the above arrangement should be the improved organisation of the gathering of data for energy/electrification planning. With knowledge of the shape of Eskom's grid extension programme, the Departments of Agriculture would be able to target the areas to be electrified and gather the necessary socio-economic and resource-use data to develop demand profiles. This would assist Eskom in defining more appropriate load variables for electrification projects, and might lead to a more economic and cost-effective placing of electric lines. It is unlikely that new information capacity would need to be created for this, but that existing capacity within the organisaations could be utilised.

If these recommendations were to be implemented, they would have a disproportionate affect on small-scale agricultural development. Both Eskom and the Departments of Agriculture would need to allocate resources to implement the recommendations, but this would be strategically justified. They might also need to modify existing policy to a greater or lesser degree. In Eskom's case the recommendations imply a significant shift in the way in which its electrification planning is done, requiring that the electricity requirements of small-scale agricultural projects, such as collective irrigation projects, are given higher priority.

Reference:

Tapson, D. 1998. The role of electricity in the development of small-scale agriculture in South Africa.

9
Rural electrification and education

Role of electrification in rural education

Education is in a poor state in rural areas – both on commercial farms and in the former homelands. Many school buildings are in a total state of neglect, and lack basic facilities such as water supply, sanitation, and telephones. Many schools are extremely overcrowded. The teaching aids and equipment available to educators are also very limited. There are often not enough teachers, and it is particularly difficult to attract experienced teachers. Teachers' living conditions are often inadequate, resulting in teachers commuting long distances to work each day.

One amongst many of the critical outcomes of the new education and training system in South Africa is the ability to use science and technology. Furthermore, a number of areas of emphasis in the new education system are in particular need of equipment requiring electrical power. These include Adult Basic Education and Training (ABET), which would require indoor and security lighting to enable night classes, and Technology Enhanced Learning (TEL), involving the use of computers and audio as well as audio-visual equipment (TV/VCR). In addition, improvements in science teaching, which require energy supply, are also envisaged. Furthermore, schools will need access to basic office equipment to enable governing bodies and staff to fulfil existing and additional administrative functions effectively. The availability of electricity is thus expected to play an important role in the implementation of a new education system.

It can be argued that it is particularly important that learners in *rural* areas are exposed to modern technologies and new approaches to learning at school, as they have less opportunity to experience first-hand many of the concepts taught in science and technology subjects than their urban peers. As the job market becomes more sophisticated, rural learners will tend to become even further marginalised in terms of access to income opportunities in the future, unless the education system addresses this problem.

Considering the severe budgetary constraints in the public sector, however, most rural schools are unlikely to be provided with a full range of equipment and electronic and other resources in the short-to-medium term. Alternative strategies are needed to achieve the above objectives – for example, only secondary schools need to have suitable energy sources for various learning areas, while many schools could use office equipment and teaching aids available at district offices or learning centres sited near schools, or a combination of these. There are initiatives in some provinces to establish Multiple Resource Community Centres (MRCCs) based at schools or other community facilities. The intention is that MRCCs will provide educational support to a range of schools in the surrounding areas by providing access to office equipment for school governing bodies and staff, in-service education and training programmes for learners and educators, and TEL and distance learning for learners.

It is also important to recognise that sophisticated equipment only contributes to teaching in a meaningful way when appropriate education material is available, where the capacity exists to utilise the technologies effectively, and when the services provided by the technology can be integrated into education adequately by teachers. Studies that have dealt with the efects of electrification at schools indicate that impacts have been limited, and are highly dependent on the context and complementary measures surrounding electrification. Under the prevailing conditions at rural schools, their electrification is likely to have a minimal impact on teaching and learning. If the effect of electrification on the quality of education is to be significant, at least the following conditions have to met:

- Electricity needs to be provided to schools as part of an integrated package of services which includes water supply and sanitation, telephones, and improved transport facilities for learners.
- The lack of educational resources at schools needs to be addressed.
- School staff and governing bodies need to have the capacity to manage and use the electricity systems and equipment.

The Eskom schools electrification programmes

Eskom extends the grid to schools within three kilometres of the existing (or planned) grid, and beyond this distance a PV (photovoltaic) system is installed. For a three kilometre extension, grid capital costs and LCCs (life-cycle costs) are substantially more than the cost of a PV system (although c/kWh costs are likely to be lower due to the higher consumption typically experienced on grid systems). This indicates that Eskom may to some extent have taken a broader view than merely comparing capital costs or LCC in determining the supply technology. While a more detailed economic analysis covering all energy sources used by schools is necessary to determine an appropriate extension cut-off distance, current indications are that three kilometres is an appropriate criterion.

It would seem that the Eskom grid electrification programme provides at least for short-term education priorities at schools – indoor and outdoor lighting, and plug points for appliances – while the supply capacity should be adequate to meet all long-term energy requirements. The PV electrification of schools by Eskom provides for some of the immediate education priorities, in the form of indoor lighting, a TV and a VCR. However, no outdoor lighting is provided where schools are supplied with PV systems. This needs to be reconsidered, as outside lighting is seen as important for security purposes and for facilitating access to schools at night, particularly for women participating in ABET activities. Eskom further provides an overhead projector to schools with PV systems, but it is not clear whether this is in fact a priority. Computers or even photocopiers may be more appropriate appliances.

The PV systems could be upgraded to allow the use of additional appliances such as computers, although this would involve substantial added expense and effort. However, costs associated with upgrading PV systems to a point where they could supply the longer-term needs of schools are likely to be prohibitive. It is thus possible that they may constrain the services offered by rural schools in the long term. Nevertheless, since it is unclear how and when schools will receive all the sophisticated equipment envisaged, PV systems need not be considered inappropriate choices for schools at present.

School electricity needs could also be met by diesel genset-plus-batteries systems. Genset-based systems have the advantage that they can be moved to other locations should the grid be extended to the school in the future, and thus may be favoured over PV in areas where the grid may extend in the medium term. The reason given by Eskom for not using gensets is the high associated operation and maintenance costs.

It needs to be pointed out that, if electricity supply option decisions are made on electricity system LCC or unit energy costs only, this will in many cases not result in the most cost-effective energy supply for the institution in question. Electricity supply options should be chosen based on a more integrated analysis of total energy use needs and characteristics. This approach may conflict with decision-making pressures and abilities within Eskom. As the number of schools electrified is seen as important, and the programmes are operated on finite budgets, Eskom is likely to place specific weight on capital costs of electricity supply as a selection criterion. They may also not be well placed to consider non-electric energy needs fully, partly because of their electrification focus, and partly because little is known concerning such needs and they may not be in a position to research them fully. The development of guidelines for a more integrated approach to the provision of energy to schools should therefore probably be facilitated by the Department of Minerals and Energy.

There are some concerns about the package of services and equipment provided to schools as part of Eskom's PV electrification programme. There seems to be a need to provide different options, rather than one standard package only. The resources required at different schools and other teaching centres are likely to differ, and need to be considered in the design of packages.

Both the grid and PV school programmes have been plagued by vandalism and theft. Such security problems relate to the bigger issue of whether one should provide a resource where there is no capacity to manage, protect and maintain the system. The security problems at schools need to be addressed, both for the purpose of safeguarding equipment, and to enable women to attend night classes where this is provided.

As yet there has been little consideration given to providing teachers' homes with electricity where solar photovoltaic panels are installed at schools, despite the benefits of extending teachers' preparation time.

Roles of institutions

The national and provincial Departments of Education need to play a key role in formulating policy on the role of electricity in supporting key education priorities. Furthermore, a range of directorates in the provincial Departments of Education (such as those responsible for curriculum development, teacher upgrading, ABET, and school management) need to provide inputs to the planning of electrification services at schools, including the targeting of schools, the choice of supply technology, and the equipment packages provided – not only those responsible for school building and maintenance. Schools' governing bodies also need to be involved in these decisions concerning particular schools.

It appears that, in terms of the South African Schools Act, provincial departments are to be responsible for paying the electricity bills of all public schools connected to the electricity grid. Departments therefore need to develop guidelines regarding the payment of electricity consumption – for example, for essential and non-essential uses of electricity.

Findings from a case study in the Eastern Cape

A case study on clinic and schools electrification was undertaken in the northern part of the former Transkei (now Region E of the Eastern Cape). Four unelectrified rural settlements were included in the study, two of which were to be provided with grid electricity, while the clinics and schools in the other two settlements were to be provided with photovoltaic systems. The electrification processes were monitored for more than two years; key findings are briefly summarised here.

Conditions in the region

During the pre-electrification study it was found that the conditions in the region were very poor. The administrative and institutional capacity in the former Transkei was extremely limited, fragmented and weak. Linked to this were the low levels of infrastructural development in the area. The low level of provision and maintenance of the most simple equipment to schools (such as chalk and paper) was of concern. Whereas most clinics had night-watchmen, most schools did not, and suffered from theft of equipment. The achievements of, and problems experienced in, the clinic electrification programme should be seen within this context (also refer to the beginning of paper).

Towards the end of 1997 little had changed at the schools. However, the provincial Department of Education (DoE) has started drawing up a 'Physical planning manual' which includes the overall plans for improvements to schools.

Coordination of the grid programme

In the past there has been no communication between Eskom's office responsible for *grid* electrification in Region E, and the DoE, including the regional and district DoE offices. Eskom has in fact dealt directly with the headmasters of schools. This situation has resulted particularly from the severe lack of capacity at all tiers of the DoE, as well as the poor communication

between the different tiers of the DoE. The communication between Eskom and the DoE at a provincial level has further been hampered by the fact that Eskom's Shelly Beach Office (in KwaZulu-Natal), which is responsible for the electrification of Region E, is not represented on the provincial Joint Steering Committee – set up as the formal channel of communication through which the Departments of Education and Health, Eskom, Eskom NGE (Non-grid electrification) and the IDT are meant to coordinate their respective programmes, including the electrification of clinics.

As a result the DoE has not been involved in planning or implementing schools electrification in Region E. While Eskom has expressed the need for the DoE to drive the process, as implementing agent responsible for the programme Eskom has continued with implementation. However, this has meant that the programme has not been informed by education needs, and that there has been no accountability regarding the impact of the schools electrification programme. Eskom has also failed to keep the DoE informed of the allocation of their budget to different schools.

The DoE has since recognised that greater levels of cooperation and communication are needed with Eskom. A post for coordinating and managing the provision of supplies to schools, and the maintenance (and training for maintenance) of schools has been established in the DoE. The DoE and Eskom have also started working closely to formulate a common strategy.

It appears that a number of schools throughout Region E received both a grid connection (points of supply / ready-boards) and a PV system. (One of the schools included in the case study found itself in this situation.) This resulted from miscommunication between Eskom and Eskom NGE. Once more the fact that the Eskom representative on the JSC is the East London Office of Eskom, whereas the grid electrification programme for Region E is driven from the Shelly Beach Eskom office, seems to have been the problem.

Other issues in the grid programme

Plans and budgets for the internal wiring of schools in the region had not been clarified towards the end of 1997. Both Eskom and the DoE faced severe budgetary constraints, which meant that prioritising of schools to receive internal wiring was necessary. Eskom had formulated tentative plans for the prioritisation process. However, the DoE needed to assist with the prioritising within the context of limited budgets and the desperate need for other improvements to schools, including renovation and additional classrooms.

There is also a lack of information at all levels regarding the payment of electricity consumption at schools, with virtually all role-players assuming that this is the responsibility of the DoE. However, Eskom decided to install prepayment meters at schools in the absence of a commitment from the DoE to pay electricity bills at schools. If the DoE does not intend to pay school electricity bills, then this should be clearly communicated to other tiers of the DoE administration and to schools. If, however, the DoE does intend to provide for payment then logistical arrangements will need to be made to facilitate this within the context of the pre-payment system.

Non-grid electrification programme

The problems identified by Eskom's NGE group, the DoE and the researchers who conducted the case study included theft and vandalism, malfunctioning PV systems, low levels of effective demand and a lack of maintenance plans/budgets. These problems related to each other in complex ways and could not be resolved piecemeal. Many of these problems resulted from shortcomings in planning, communication and consultation in the programme. The extent of the problems led to calls from the DoE to halt the programme. Eskom agreed to slow down the programme and to electrify only 169 of the planned 3000 schools in 1997. The two key players (NGE and DoE) have since been working closely to ensure that the DoE will play an appropriate role in the programme, and to locate the electrification programme within the context of other improvements at schools.

The security situation at schools and reports of widespread theft of batteries led the DoE to delay the disbursement of appliances to schools. A classic 'chicken and egg' scenario has developed in some instances: without appliances the PV electrification of schools is seen to have little benefit, which leads to an unwillingness on the part of local residents and school staff to allocate scarce resources to the safeguarding of these systems. At the same time, the DoE refuses to distribute the appliances because of the lack of security.

The DoE did not have a budget for school security and tried to resolve the matter by shifting this responsibility to local residents and schools staff. The resolution of these and other problems may, however, prove to be difficult. Local people are unlikely to 'take ownership' of PV systems at schools, particularly if they are seen as having little or no benefit to the schools themselves or to local residents in general. Local people and schools were not consulted with regard to the installation of PV systems at schools; at best they were simply informed that this would be happening. This has been reinforced by a failure to communicate the role of PV schools electrification within a larger development framework, including other improvements to schools. Questions have been raised at a local level as to the rationale for electrifying school buildings which are 'temporary structures' and which have been falling increasingly into disrepair. Clear prioritising from the DoE on how it plans to use its limited resources would help to clarify these issues. Finally, people in non-grid areas frequently do not understand why some areas are provided with grid electricity, while theirs are not. It may help if this is addressed at a national level. It should not be the responsibility of the NGE programme or the DoE to address this, as it is a much broader issue.

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10
Rural electrification and health

Role of electrification in rural health

Health can be seen primarily as an outcome of interactions and decisions made at the *household* level, which are constrained by external factors. Rural electrification can potentially play a role in improving health at the household level – for example, in reducing domestic air pollution and thus the incidence of acute respiratory infection, as well as in reducing the incidence of burns and paraffin poisoning. However, the majority of poor households with grid electricity do not convert to electricity as their only, or even major, source of energy, but continue to use an array of fuels. Problems like respiratory infection, burns and poisoning are therefore not resolved by electrification, although access to electricity probably reduces the incidence of these problems.

Public services can also play a role in improving health in rural areas. For example, the provision of water and adequate sanitation at a household level has been shown to be the most effective infrastructural intervention in the promotion of health. Furthermore, primary health care is seen as the most suitable way of providing health services in rural areas. Although primary health care is most effective when implemented at a *household* level, within the national health plan of South Africa clinics are the major vehicles for it in rural areas.

Electricity has the potential to improve both the range and quality of services provided by rural clinics. The potential benefits of electrifying rural clinics include the ability to use better technologies, offer longer opening hours (including 24-hour or emergency services), ensure better maintenance of the vaccine cold chain, offer educational opportunities to visitors and patients, and increase clinic security, as well as the improved ability to attract staff. As in the case of its potential role at a household level, however, this may not be realised as a result of other factors. For example, many clinics do not have all the equipment on the national Department of Health's Essential Equipment list, or additional equipment such as a means of communication. Nevertheless, it should not be assumed that the provision of suitable technology and an appropriate energy supply are the major factors in improving the services provided by clinics. For example, it seems that vaccination programmes are more likely to fail because of human behaviour (such as the failure of parents to bring children for vaccination, and the inadequate maintenance of fridges, infrequent testing of fridge temperatures, and the storage of staff goods in fridges) than because of technical problems in the vaccine cold chain process (such as a failure of the energy supply). Therefore the technical components of the programme are only effective insofar as equipment is adequately maintained, and the people who are implementing the programme are well-trained and have adequate facilities for their own use. The provision of an adequate electricity supply to clinics is therefore merely one input into facilitating improved services at clinics, and is typically not the most important input.

It seems that the impact of electrification on health in rural areas will depend on the extent to which the following recommendations are implemented:

- Electrification need to happen as part of a broader coordinated and community-based programme which addresses infrastructural deficiencies that affect rural households as well as clinics, including water supply and sanitation, telecommunications, roads, and energy supply more broadly.
- It should, further, happen as part of a broader coordinated and community-based rural development programme which addresses poverty, violence, illiteracy, the status of women, etc.
- Broader problems experienced at clinics, which are not related to the availability of electricity supply, need to be addressed.

- Health interventions should take place at the household level and not only at clinics.

The IDT clinic electrification programme

It has been found that the IDT (Independent Development Trust) clinic electrification programme addresses rural health care priorities reasonably well. All the rural health care service priorities – vaccine refrigeration, two-way radios, indoor and outdoor lighting, staff lighting and a TV plug point, and a medical examination light – are catered for in the photovoltaic (PV), grid and genset-plus options provided. Nevertheless, it is recommended that the national Department of Health should establish a policy that clearly sets out the role of electrification in improving health in rural areas. This will better equip the department to drive and take ownership of the current clinic building and electrification programmes.

Among the main criteria used in energy technology selection in the IDT programme are system capital cost and life cycle cost (LCC). These translate into the following broad guidelines:

- grid connections for clinics within 1km of the grid;
- genset-plus systems for clinics between 1 and 5km from the grid;
- PV systems for clinics more than 5km from the grid.

The genset-plus system is intended as an interim solution for areas where grid extension is anticipated in the short-to-medium term. This appears to be an appropriate strategy, although it is uncertain who will be responsible for relocating such systems should grid be extended to the area, and how effectively this will be done.

If LCCs of PV, grid and genset-plus options for providing electricity to clinics are compared, and costs of meeting thermal and other services are included where they are not provided by the electricity option, indications are that grid extension is likely to be an economically sound choice for between 1.5 and 2km extension distances. If it is also considered that grid extension will be able to accommodate rural health centre upgrading in a way that the other supply options will not, there may be a case for extending the grid extension cut-off to two or even three kilometres. However, capital costs and LCCs for grid extensions over one kilometre tend to be more than the cost of PV systems, and substantially more than the cost of genset-plus systems (if other energy service costs are not considered). As there is some pressure on the IDT to electrify significant numbers of clinics, and the programme has a finite budget, capital costs are given particular weight in the IDT programme. This is probably why the one kilometre cut-off distances is used.

The range of services provided by rural clinics is likely to be extended in future to include 24-hour emergency services, in-patient facilities, and adequate neo-natal care. This implies extended lighting hours and power for a greater range of medical appliances such as incubators and sterilizers, and possibly extra staff facilities. The ability of the power supply to accommodate such upgrading may thus be important. It is estimated that this would imply the provision of at least 16kWh/day, and might require a supply capacity of 20A (at 240V). Currently, IDT PV systems provide about 2kWh/day (peak demand capacity is about 500W), and grid systems are 60A, 240V single-phase connections. (Three-phase electricity is unlikely to be needed by clinics for any important health services.) It is well within the capability of the grid systems to handle substantial increases in service provision at clinics, but it is far beyond what a PV system could be expected to provide at reasonable cost. PV systems could thus become inadequate electricity supply systems over the longer term for rural clinics which are upgraded to 24-hour health centres. It should be noted, however, that while such an upgrading of rural clinics is a logical target given the national health priorities, whether and when this may be done is unclear, and thus it is far from certain that PV systems will ever in practice be a constraint to such upgrading.

The IDT clinic programme has not yet ensured that a sustainable maintenance programme for their systems exists beyond the one-year guarantee provided by the PV system installers. While they have allocated funds for maintenance for the next 10 years, systems by which these funds are utilised have not been institutionalised. The sustainability of the IDT programme will thus remain in question until this issue is addressed.

Use of non-electric energy options at clinics

Vaccine refrigeration can use LPG (liquefied petroleum gas) as an energy source, which can be as reliable as solar or grid electric options, depending on the reliability of the gas distribution networks – which in some rural areas appears to be questionable. Gas may also be used for heating applications such as space heating, cooking or sterilising, which PV systems or gensets may not be able to provide. The adequate provision of such energy needs should therefore be considered alongside upgrading of clinic electricity provision via PV or genset-plus options by the planning agency concerned. The relevant agency should at least facilitate the coordination of different supply options by the various energy service providers.

Large uncertainties exist in the energy use characteristics of clinics (particularly non-electric energy needs), and as a result it is difficult to determine realistic costs of energy use. For example, in practice grid-connected clinics may continue to use LPG rather than electricity for cooking and space heating, because LPG supply systems are already in existence for many clinics, and LPG appliances are already installed. The total cost of energy provision to such clinics would be higher than if all these needs were being met by grid electricity.

If electricity supply option decisions are made on electricity system LCC or unit energy costs only, this will in many cases not result in the most cost-effective energy supply for the institution in question. Electricity supply options should be chosen based on a more integrated analysis of total energy use needs and characteristics. This approach may be in conflict with decision-making pressures and abilities within organisations such as IDT and Eskom. As the number of clinics is seen as important, and the programme operates on a finite budget, they may place specific weight on capital costs of electricity supply as a selection criterion. They may also not be well placed to consider non-electric energy needs fully, partly because of their electrification-focus, and partly because little is known concerning such needs and they may not be in a position to research them fully. The development of guidelines for a more integrated approach to the provision of energy to clinics should probably be facilitated by the Department of Minerals and Energy.

Findings from a case study in the Eastern Cape

A case study on clinic and schools electrification was undertaken in the northern part of the former Transkei (now Region E of the Eastern Cape). Four unelectrified rural settlements were included in the study, two of which were to be provided with grid electricity, while the clinics and schools in the other two settlements were to be provided with photovoltaic systems. The electrification processes were monitored for more than two years. The key findings on clinic electrification are briefly summarised here.

Conditions in the region

During the pre-electrification study it was found that conditions in the region were very poor. The administrative and institutional capacity in the former Transkei was extremely limited, fragmented and weak. Linked to this were the very low levels of infrastructural development in the area. There were an insufficient number of clinics in the region. Existing clinics were, furthermore, not adequately supplied with equipment, and their maintenance needs were not adequately met. Key needs at clinics that were not being met included water supply and telecommunications. The isolation of nurses at residential clinics had led to low morale and absenteeism. The achievements of and problems experienced in the clinic electrification programme should be seen within this context.

Towards the end of 1997 it was observed that, apart from the benefits of electrification, supplies of medicines and basic requisites were more plentiful at some of the clinics, the renovation of one clinic was in progress, while improved water supply was being planned in the area where some of the clinics are located.

Coordination of the programme

The degree of coordination which has been achieved by the IDT, its consultants, and the provincial Department of Health (DoH) resulted in effective consultation, implementation and

resolution of problems in the case of the *non-grid* clinic electrification programme. Although the DoH is short-staffed, and this has led to some communication problems, liaison between the IDT and the DoH has been extensive. Throughout the planning and implementation of the electrification programme, there has been a regional person in the DoH whom the IDT contacted for trouble-shooting on a day-to-day basis. The relatively high levels of coordination within the various tiers of the health administration in the province have also led to a vertical integration of planning. The relatively small scale and slow pace of the planning and implementation processes have permitted clinic-to-clinic planning and implementation and high levels of local-level involvement.

The degree to which coordination has been achieved in the *grid* clinic electrification programme has been difficult to gauge due to the stalling of this programme as a result of various problems experienced. The lack of clarity regarding Eskom's grid electrification plans in the region has created planning constraints for the IDT, but this should be seen in the context of the difficulties Eskom has experienced in working with Tescor plans for the former Transkei areas, as well as cuts in Eskom's electrification budget. Some clinics which were to have been electrified in the course of the five-year plan have now been delayed or have fallen outside this process altogether. (One of the clinics included in the case study was affected in this way.) The IDT has further experienced difficulties with the tendering process for internal wiring of clinics in the region. At the other clinic included in the case study, that was to be electrified with the grid, considerable confusion existed regarding the ownership, renovation and electrification of the clinic, with staff from the DoH, IDT and Eskom taking different views.

Generally there seems to be a breakdown in communication between the IDT and Eskom's Area Office responsible for grid electrification in the region. A formal channel of communication exists through which the Departments of Education and Health, Eskom and the IDT are meant to coordinate their respective programmes, including the electrification of schools, in the form of the provincial Joint Steering Committee. However, the Eskom grid electrification programme for the Eastern Cape is represented by a staff member from the East London Office, while the grid electrification programme for Region E is driven from the Shelly Beach Eskom Office in KwaZulu-Natal.

The integration of electrification with the upgrading of clinics has been problematic in some instances largely due to capacity constraints within the Department of Public Works in the region. This also has implications for improvements in road networks serving clinics, which is another priority.

Teething problems in the implementation of the new health administrative system at a district and local level led to some degree of duplication of roles between the hospitals and the new district health offices.

Participation and communication at a local level

The IDT has tended to work through the DoH in order to facilitate local-level liaison and participation. Electrification plans have been passed through to the local structures by personnel from the regional DoH office via hospitals and district health offices, and input from local structures has been passed on to the IDT via the regional DoH office. At the final planning stage, each site is visited by the consultants, contractors and the DoH District Officers and community health matrons from the hospitals who meet with nurses and tell them of the plans. Various issues, such as the location of plug points and of the refrigerator, are discussed. The regional DoH office is responsible for ensuring that clinic staff know when the contractors will be at their clinic to do the installation. The close coordination at a local level has facilitated the rapid resolution of problems as they have arisen.

A common problem is inadequate communication with people at a local level. This is particularly true with respect to the planning and implementation of the grid electrification programme, where changes in plans have occurred which have not been communicated to local people. Furthermore, contractors undertaking the maintenance of PV systems and equipment in some cases have not provided and information to clinic staff regarding their identity and actions. Generally local residents in rural areas need to be informed of the status of

the grid and non-grid electrification programmes, as well as the limitations of the non-grid programme.

Broader development of non-grid areas

One clear result of the clinic (and schools) electrification programmes is that questions are being raised by local residents in non-grid areas regarding the electrification of other structures in the area, and household electrification in particular. In the interests of greater equity between grid and non-grid areas, every effort needs to be made to plan the development of new services and improvement of existing services other than schools and clinics in areas not to be electrified with the grid. In particular, this relates to the provision of solar-powered water systems, alternative electrification of public buildings, churches, pre-schools, crèches and teachers' homes. The possibility of linking solar electrification of schools and clinics to other improvements such as solar street lighting should also be explored. Household electrification needs to be addressed as a matter of priority.

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11
An integrated approach to electrifying rural households

The constraints that energy poverty imposes on a development strategy are still invisible in the mainstream development debate. The ways in which energy needs are met has enormous implications for low-income households, but the householders themselves, unlike policy-makers, do not separate the urgent need for land, water, housing, energy services, education, health, transport and employment in a sectoral way. In post-election South Africa a historical conflation of two separate issues has occurred: the need for the provision of 'energy services for development' to the majority of the population (the household sector), and the provision of electricity as one satisfier of energy needs as part of the electoral promise of the ANC to redress energy inequity.

The Rural Electrification Project has attempted to address crucial questions, which are foregrounded by the choices and problems facing rural people, for energy planners. Can rural electrification substantially alter rural energy poverty? Is electricity an appropriate, affordable, healthy and safe satisfier of rural energy needs? How significant is electrification as a factor in meeting overall rural development goals? To what extent can the rural electrification programme be motivated by its contribution to rural livelihoods, poverty alleviation and quality of life?

We do know that the consequences of energy choices are profoundly gendered and that they affect household members in different ways. Amongst the reasons for the 'invisibility' of energy is that, although men and children are involved in fuel-related work, management of household energy needs is 'women's work' and, in keeping with the lack of recognition for women's (and children's) labour generally, inadequately recognised. However, using gender as the only or primary lens obscures other, equally important relationships around fuel – in particular, the fluidity of labour allocation to reproductive fuel-related tasks such as wood collection, washing and cooking; and the relative wealth of households, as well as the differential status of individuals within households. Thus, the study uses the discursive devise of Mrs Mohlamonyane to indicate gender (and race and class) as analytical variables rather than to pinpoint energy as a 'woman's issue' or to categorise 'rural women' as an undifferentiated group.

The convenience of electricity – its capacity to increase comfort and pleasure and thus to reduce the difficulties of life – depends on the intensity and frequency of its use, and the end-uses to which Mrs Mohlamonyane can afford to put it *without intensifying her economic marginality*. This depends on a range of other factors: whether she receives a current-limited supply or a 20Amp supply; a solar or a grid supply; the extent to which her house is wired; her access to efficient appliances which will not electrocute her or her children; whether she will need to continue to use and pay for a range of other fuels and appliances; and, centrally, whether she can afford to use electricity for all or most of her cooking (and other thermal needs such as heating water and space) and thus reduce her reliance on wood fuel.

Summarising the potential benefits

The assumptions about benefits of electrification exist primarily in the minds of planners (and perhaps recipients) as unexplored, uncritical 'common sense'. In terms of the evidence from the studies done in the RE project, we have attempted to assess whether electricity has a role to play? As shown in the matrix below, quantifying the contribution of electricity to the development of rural areas remains elusive:

Electricity will play a role in:	
Improved living standards	qualified yes
Improved quality of life	yes or a qualified yes
Reduced domestic burden for women	uncertain, likely for some
Time saving	uncertain
Improved communication	uncertain
Lighting for 'longer days'	qualified yes
Improved education through providing lighting for evening study for school children and adult learners alike	uncertain, towards positive
Improved education and educational services	uncertain
Lowered fertility rates	uncertain
Reduced crime rates/ improved safety	yes
Environmental benefits, such as alleviating the pressure on local fuelwood	uncertain, dependent on income
reduced urban migration	uncertain, unlikely
improved political stability and security of rural communities	uncertain
Improved health and safety	qualified yes

An assessment of the role of electrification in the provision of energy to rural areas cannot be complete without mentioning its potential negative roles. Hire purchase schemes which demand regular payment regardless of fluctuating household fortunes put pressure on households so that expenditure on bills may take precedence over basic needs. There are also the dangers of shocks or electrocution when people do their own wiring, the possible burden which regular or flat rate payments put on the budget. There are also cultural or gender relations which do not permit cooking and entertaining in the same space, and prevent women from cooking in the same space as the social area.

Improvements of physical health

The immediate presenting causes of energy-related ill health or mortality at the level of the household are burns, respiratory illness, and paraffin poisoning. South Africa's burn mortality rate – caused by household fires related to accidents with candles and paraffin stoves, and uncontrollable fires in high density informal settlelements – is approximately four times higher than that of the industrialised world. Children still pull pots of burning water or oil upon themselves in electrified houses, and they drink household poisons such as paraffin even in the low-density high-income white suburbs, with the same serious but usually nonfatal results.

While it seems that electrification is the quickest and easiest way to break the chain of causes and consequences of energy-related ill health, the situation is in reality far more complex. Changes may be needed in both technology and social custom and practice. Given the current constraints to her consistent use of household electricity, and Mrs Mohlamonyane's current political, social and economic immiseration, rural household electrification is of minor importance in the production of the physical health of her household.

Mental health and self esteem

Electrification is a potent symbol of access to 'development' and 'modernity'. The perception of being valued enough to be electrified – with the implicit promise of other improvements to follow – should not be underestimated. The belief that change is possible, and that its symbol is the delivery of household electrification, may be of great psychological benefit to Mrs Mohlamonyane in her 'difficult' life. Rural household electrification, then, may be an important

investment in the 'politics of hope'; that which sustains people and continues to encourage positive action towards social transformation.

Education, electrification and media

Mrs Mohlamonyane's children will probably find it far more convenient to study by electric light, should they wish to, and should they have the time, energy and resources. Mrs Mohlamonyane herself may be encouraged to attend adult education classes, community meetings or skills training activities in the evening if the school is electrified and it is safe to get there and back.

Access to formal and informal education at home depends on the quality of and access to the mass media, the presence or absence of adult education and training initiatives, and the different motivation and interests of Mrs Mohlamonyane and the various people who live with her. Electric lighting is a boon to motivated students or self educators, but there is obviously no direct connection between provision of good quality lighting and its educational use.

Television is increasingly seen as an important source of entertainment and childcare, and there is social pressure to provide these good things of life. There is a certain ambiguity inherent in the national creation of a media 'culture of representation' – a curious mix of worthy efforts to dispense information, news, education – and the creation of a media market.

While national top-down radio and television programmes tend to reinforce the situationist slogan that 'participation in an illusion is the illusion of participation', the opening up of broadcasting which has resulted in a lively, localised community radio 'movement' is a potentially exciting and radical extension of democracy. A radio station which is focused on her practical and strategic needs and welcomes her participation is an opportunity for Mrs Mohlemonyane to break her social and economic isolation and begin to involve herself directly in the decisions that influence her well-being.

The contribution of electrification to household health through the extension of electrically powered radio and television media is also potentially very important. The mass media could help to educate the general population to recognise the signs of obstetric and other medical emergencies at both household and 'community' level. This is a useful role for local radio stations as well as national television and radio 'edutainment' such as the Soul City initiative, which currently has enormous popular reach and valency. We should treat cautiously, however, the extravagant claims that are often made for mass media's ability to change attitude and behaviour.

Politics of the household – consequences for electrification

It has been noted that while women tended to have equal or primary decision-making power over the buying of food and clothing, men made the decisions on purchases of alcohol, cigarettes and other items of luxury consumption. Can we expect to see a pattern of male decision-making in so far as choice of appliances goes, since men may have greater control over cash resources? In terms of acquisition priority, will television sets be privileged over domestic labour-saving appliances such as electric kettles, hot plates or stoves – and would this necessarily indicate male choice?

Electrification may affect the construction of gendered spaces within the domestic unit. 'Traditional culture' does not consider it appropriate to cook and entertain in the same space – thus where one room has been electrified, women have been reported to retire to cook over smoky fires outdoors. But material culture is reflexive and may have its own effect upon social relations; what will be the effect on 'tradition' of the household encirclement of a television set, rather than a fire, in the evenings?

Electrification and economic development

We have seen that the role of energy in economic development is complex and overdetermined – there is no direct relationship between household electrification and increased production or levels of income. Furthermore, there is no evidence that very poor rural people will be able to make a 'full transition' to the use of electricity, in the short or medium terms at least.

Rural immiseration is associated with the lack of essential services such as clean accessible water and affordable, healthy and convenient fuels and appliances, but not directly caused by them. Where there is a dynamic rural economy, the absence of electricity may be a significant constraint on output and living standards. The availability of electricity alone, in the circumstances in which Mrs Mohlamonyane lives clearly will not induce 'economic growth'.

Electrification and rural stability

In South Africa, where, as we have seen, rural and urban areas are locked into an asymetrical, unstable but entrenched relationship, circular migration is likely to continue into the forseeable future. Because of the extreme destitution of many rural areas, household electrification is unlikely to decrease rural urban migration. Many members of the Mohlamonyane household are likely to seek work as migrants in the conurbations for shorter or longer periods during their lives.

However, rural household electrification may contribute obliquely to the maintainance or even increase of the investment of urban wages in remittance as cash income for rural relatives, as capital for rural housing, or as investment in agricultural equipment or cattle. (Cattle in particular have multiple uses in rural livelihood strategies, and susceptible as they are to periodic drought, are an important indicator of relative wealth.) Household electrification may be one of a package of services and new entitlements which may encourage long-term social investment in rural stability.

Rural areas for very poor people of African origin continue to provide important resources to support life in town – relatively secure tenure for old age or illness, a dumping ground or place of care, depending on circumstances, for children who cannot be taken care of under conditions of extreme urban stress. In the absence of any realistic hope of agrarian reform or significant rural economic development in the immediate future, rural dwellers are reliant in turn on support from the urban areas, in the form of regular or irregular remittance from wage earners, state pensions or subsidies, and, important for the elderly, child labour. Structural unemployment is a feature of the South African economy, and effective job creation to the scale urgently required to sustain a permanently urbanised population remains elusive. Under these circumstances many urban workers may need to continue to invest, or increase investment in the future, in rural households.

An integrated approach

The purpose of an integrated approach would be to maximise the effect of rural electrification, while recognising its limited potential in current conditions to meet what are arguably the most important of all – thermal – needs, and thus paying attention to the provision of biomass and hydro-carbon fuels to provide the latter. Current efforts in areas which are not going to be connected to the grid are focused on a combination of solar home systems to supply lighting and media requirements and gas for thermal applications. Pilot studies of this combination are being conducted in several areas and solar home systems are also being marketed independently. However, the two-plate gas stoves currently being sold as part of this mixed package preclude baking; a stove to suit all purposes should be designed.

Paraffin is used by 82% of all rural households for cooking and some space heating and deserves a great deal more attention than it currently receives. Informal distribution systems work relatively well, but the cost to the consumer is far higher than it could be particularly in rural areas. Ensuring bulk supplies to depots in rural areas may be one way of containing prices another would be to make paraffin VAT zero-rated. But neither the DME and the Department of Finance have given this proposal serious consideration. These rural 'energy depots' could be used as supply points for LPG and wood off-cuts as well as low-smoke coal which is currently being developed. Co-operation would also be required at local level, to facilitate suppliers finding collaborative solutions such as transport sharing, and co-operating to their and the customers' benefit in the interests of developing rural areas as an investment in the economic well-being of the nation.

Integration is needed both horizontally and vertically. Horizontal integration requires the incorporation of energy technologies, for example fuel-efficient stoves with forestry, education, health care, protection of the environment, and the promotion of small-scale industry within rural regional development. A strong recommendation is that RE plans should be integrated development plans. Such a process would entail a major reorientation in institutional arrangements and structures and is the subject of an EDRC research project in 1998/99. The implications for integration at policy level, strategy level, programmatic and institutional level will be investigated in this study.

In terms of air quality and safety in using paraffin, coal and fuelwood, co-operative action is needed, between the DME, NGOs CBOs and designers and producers of low-smoke coal, stoves and chimneys to reduce dependence on smoky and dangerous fires, reduce indoor pollution, and ensure safe paraffin appliances. This would require a lead from the DME and co-operation with the South African Bureau of Standards. The DME already have a low-smoke coal programme in place, but its acceptability and viability has still to be proved.

Within the DME there is also a need to facilitate collaboration rather than competition between the energy sub-sectors, and ensure the co-operation of the petroleum, electricity and off-grid directorates to the benefit of low-income groups.

Energy policy for the rural poor should facilitate informed choice and safety in selecting from a wide range of options to suit the variety of needs and conditions. This would mean understanding demand as well as supply side issues and continual analysis of policy options and monitoring of activities from multiple fuel use and energy efficiency to government strategies for ensuring the energy security of the poor.

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Electricity and small, medium and micro-enterprises

Potential role of electricity in SMME development

Three types of enterprises can be distinguished in the small, medium and micro-enterprise (SMME) economy:

1. *Survival enterprises* of the informal economy: A set of activities undertaken primarily by people unable to find regular employment. There is scant prospect for opportunities for upward growth into viable small business enterprises.
2. *Micro-enterprises:* Small enterprises often involving the owner, some family members and, at most, one to four employees. Although they frequently are not formalised, many of them will become viable formal small businesses.
3. *Small and medium enterprises:* These constitute the basis of the formal SMME economy, and employ between five and 200 people.

Rural SMMEs in South Africa are overwhelmingly of a survivalist nature and thus non-lucrative, with limited impacts on employment or wealth creation. In fact, the majority of activities generate meagre incomes and can be classified as 'desperation strategies'. They are, further, narrowly concentrated in a limited number of activities, particularly in the overtraded retail sector. There is thus a serious lack of diversity in the rural SMME economy, as well as a virtual absence of small-scale rural industries.

A key development objective with respect to the rural SMME economy in South Africa is to encourage the development of micro-enterprises and formal SMMEs. The core policy inputs required to encourage the establishment of commercially viable SMMEs in South Africa are improving access to finance/credit, markets, training and information. Electricity is not an important input to augmenting the local rural SMME sector or to achieving the major objectives of the SMME sector as a whole. In some areas, however, infrastructural deficiencies – including shortcomings in telecommunications, postal services, sewerage and roads, as well as electricity provision – are extremely problematic for rural SMMEs, particularly small-scale manufacturers.

Electrification has some impact on SMMEs, even if this is modest:

- Electrification results in the 'modernisation' of existing rural SMMEs. By 'boosting' survivalist enterprises (such as spaza shops) in this way, electricity probably makes an important contribution to the livelihood strategies of rural people vulnerable to extreme poverty.
- In most cases electrification exerts only a modest stimulus for the growth of new enterprises. New businesses that are formed when an area is electrified are most likely to be survivalist retail and service enterprises (such as small shops, bars, or providers of personal services). This is often linked to the use of electricity for refrigeration. New micro-enterprises, which have a better prognosis in terms of secure incomes as well as longer-term success, are much less common, especially those in the production/manufacturing sphere.
- Access to electricity can significantly affect some small-scale manufacturing enterprises in particular – for example, garment-making, and work requiring welding equipment and power tools – by enabling them to upgrade to more effective technology and thus improve their productivity. However, these currently comprise a very small percentage of SMMEs in rural areas.

The impact of electricity is likely to be greater if it is not provided to small businesses in isolation, but as part of a larger package of complementary inputs, such as the extension of rural credit and greater access to markets.

It is also important to realise that an increase in the number of rural SMMEs cannot necessarily be seen as an indication of economic growth in the area. Even new production/manufacturing SMMEs can be manifestations of deepening poverty in rural communities – for example, as a result of an increase in unemployment, rather than an indication of economic growth.

Programmes to support SMME development

A new institutional framework for SMME promotion has been established by the Department of Trade and Industry to address the development priorities in the sector. Bodies which have been formed for this purpose include the Ntsika Enterprise Promotion Agency (NEPA), Khula Enterprise Finance, the National Small Business Council, and provincial SMME desks. NEPA is charged with implementing the national SMME strategy. At the heart of the programmatic interventions by NEPA is the establishment and accreditation of a network of local business service centres, which are to deliver essential business support and core services, including training, information/advice and counseling to SMME entrepreneurs. The central activity of Khula Enterprise Finance is to facilitate access to the key input of finance for SMME development. The role of the provincial SMME desks is to function as co-ordinating bodies for SMME support programmes and activities at the provincial level, and to conduct provincial planning for SMME development.

Eskom's SMME unit seeks out businesses already functioning and new business opportunities during pre-electrification investigations and through the electrification process. Activities of the unit include training electricity installers and developing franchises with local entrepreneurs in a range of activities such as for the provision of refrigeration, laundry, and bakery services. Although the SMME programme focuses on urban areas, activities also extend into rural areas as a part of their overall objective to support economic development in all areas to increase the affordability of services such as electricity in the longer-term. Types of small rural business supported include cooperatives, bakeries, knitting clubs, chicken farms and brickmaking.

Eskom is a relatively minor player within the overall spectrum of rural SMME development, however, particularly as compared to the emerging key institutional actors mentioned above. The broad activities of Eskom's SMME development programme seemed to fall largely outside of, and were only marginally linked to, these institutions. The only notable linkages of Eskom to the new national structures for SMME development occurred at the provincial level, where Eskom has contact with provincial SMME desks through its representatives in each province and its participation in provincial forums for SMME development. A much greater degree of coordination and cooperation is necessary between Eskom and the institutions responsible for SMME development.

Electricity supply options for SMMEs

As the SMME sector is overwhelmingly survivalist in rural areas, and many rural small businesses operate from households, SMME electrification is closely linked with household electrification.

Photovoltaic (PV) systems could provide the power needs of many survivalist businesses, although the refrigeration needs may well require a system too expensive for many small spaza shop owners. Because of the high energy demand and thus PV system cost, it is also unlikely to be a suitable system for businesses requiring any substantial refrigeration or freezing requirements, or running any workshop equipment. Its use for SMMEs is therefore likely to be restricted to lighting applications, running small motor driven applications such as sewing machines, TVs, and possibly limited refrigeration. Since the vast majority of small businesses in rural areas are survivalist, PV systems may have substantial application here, although capital costs of these systems would be prohibitive in most cases. Without financing, PV systems are, therefore, unlikely to be affordable to many small businesses.

While a 2.5A grid electricity supply would limit appliance use in a similar way to PV, the larger capacity grid supplies would be able to provide the requirements of even substantial workshops. Grid supplies of 60A capacity and 3-phase electricity is only likely to be required by large established businesses using heavy duty equipment, and thus is unlikely to be a common need of the rural SMME sector.

Gensets could be used to power any scale of business if sized appropriately but, where electricity is required for any length of time, genset capacity factors are likely to be low and thus the fuel efficiency poor. Genset-plus systems may be better options in such cases, although their cost-effectiveness is expected to be highly site specific and their suitability is still unproven. Gensets are often the only option for businesses requiring any substantial amount of power where the grid is far away. They are, however, often inappropriate because of the need for continual fuel supply, regular maintenance and occasional repair, while their fixed supply capacity can also limit business growth.

Grid supply has the advantage that it is usually easily and relatively cheaply upgradeable, and thus can accommodate business growth. PV systems, or genset systems would normally accommodate expansion less easily. In general a grid connection is likely to be the most convenient, cost effective and versatile option where extension distances are not too great.

The Eskom SMME unit considers the specific business needs when advising on supply capacity required. Typically, 20A or 60A single-phase supplies are provided with a three-plug ready-board, a single overhead light and a pre-payment meter. This indicates that businesses supplied are substantial users of power or that Eskom provides substantial overcapacity to many of them.

It is noteworthy that Eskom's SMME programme does not extend to any significant degree into areas where grid extension is not planned. Many enterprises in rural areas will, therefore, have difficulty accessing support regarding appropriate electricity or energy supplies for their needs, and this will need to be addressed given the importance of SMMEs in national development plans.

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Over the last three years the Energy and Development Research Centre at the University of Cape Town has been involved in a comprehensive research project on *'The role of electricity in the integrated provision of energy to rural areas of South Africa'*. The overall aim of the project has been to assist with the development of rural electrification policy that is consistent with South Africa's national and regional development goals.

The project reviewed rural electrification experience both within and outside South Africa, before taking a systematic look at a range of practical implementation and policy issues. Over the three years a total of 45. research reports and papers have been prepared by EDRC staff as well as researchers from a range of other organisations around South Africa. The reports have been subject to review by South African experts in the various topics and in addition, the more recent papers have been reviewed by a number of international rural electrification specialists – Gerald Foley, Elizabeth Cecelski, Venkata Ramana and Tore Horvei.

The project was funded by the Norwegian Development Agency (NORAD), the South African Department of Minerals and Energy and Eskom.

The research areas covered

1. *Background information*

International literature review
Review of South African experience
Energy demand data analysis

2. *Case studies*

A number of case studies were undertaken with the aim of assessing the impacts of electrification amongst rural villages, at schools and clinics, amongst workers on commercial farms, and small-scale farmers.

3. *Operational policy*

Planning data resources
Policy and criteria for the selection of rural electrification projects
Project appraisal/cost-benefit analysis methodology
Technology/supply options
Acceptability of different electricity supply options primarily current-limited supplies
Financial and economic analysis of supply options
Evaluation of grid and non-grid electricity supply options
Community participation in rural electrification

4. *Public policy*

The development context
Integrated planning framework for rural electrification
Rural electrification scenarios – financial analysis
Role of rural electrification in development
The role of rural electrification in promoting health, education, small business development, small-scale agriculture in South Africa.
Equity and empowerment in rural electrification programmes.

How to get hold of the research

A number of complete papers are available to be downloaded for free from our internet web site. Also available, as a set of summary papers, is an overview of the issues dealt with during the project, as well as the results and recommendations.

The summaries and all the papers are also available in printed versions – the summaries free, the papers at cost price, depending on the length.

See EDRC's website at: www.edr.uct.za

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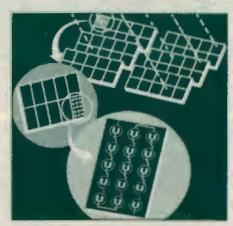

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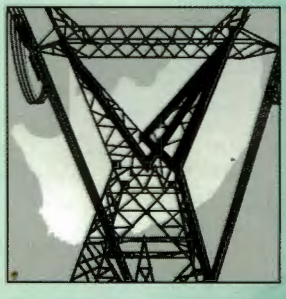

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