

Rural electrification in South Africa

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EXECUTIVE SUMMARY

Background and scope of paper

This paper on *Rural Electrification in South Africa* is written as part of the Energy Policy Research and Training (EPRET) project at the Energy for Development Research Centre (EDRC), University of Cape Town. The purpose of the EPRET project is to develop policy options for widening access to basic energy services for the urban and rural poor in South Africa.

The electrification of the homes of the poor is becoming an increasingly important issue within development debates in South Africa. It is assumed that a new democratic government will remain firmly committed to a programme of redistributive investments in rural areas, including the rapid improvement of levels of service provision.

Rural areas in South Africa are characterised by severe poverty, low productivity and limited access to land, gainful employment or public services. This is true both in homeland areas (the TBVC states and the SGTs) and for rural areas of RSA, the latter consisting mainly of farmworker households on commercial farms. Rural development is a complex and difficult process which requires well-conceived and integrated policy interventions. There are many constraints to sustained rural development, amongst which is inadequate energy supply.

The total number of rural households is estimated to be about 3.2 million, of which 0.9 million are rural farmworker households on commercial farm lands and 2.3 million households in 'homeland' areas in the SGTs and the TBVC states. Only 0.2 million of these household have access to electricity in 1993. The number of rural households on a national level is *not* expected to change much up to year 2010, the planning horizon for the EPRET project.

The aim of the paper is to set out guidelines for a major rural electrification (RE) programme for the 'new' South Africa. The paper examines necessary socio-economic (inter alia ability and willingness to pay) and financial preconditions for a comprehensive RE programme to be successfully implemented. More specifically, the principal objectives of the paper are to:

- consider briefly possible links between rural electrification and rural development or vice versa;
- discuss the scope for electrification in South Africa (rural, peri-urban and urban);
- describe ongoing electrification in rural areas in South Africa;
- state the framework (financial and otherwise) for future South African electrification;
- develop and analyse scenarios for rural electrification in South Africa; and
- derive conclusions, guidelines and recommendations for a sustainable South African rural electrification programme.

The paper does not take sides in the ongoing debate about the size and tempo of a RE programme. On the other hand, the paper does point out inherent goal conflicts in attempting to raise the living standards of the South African poor on a wide front within a short period of time.

Rural electrification and rural development

Human activity, be it in urban or rural settings, is dependent on energy. Each mode of production, agrarian or industrial, and the derived role of households within them, has its own energy needs. When fuel requirements change on account of new economic activities, the supply of energy comes under pressure to adapt to satisfy new needs.

It is unlikely that the introduction of new forms of energy in itself would lead to or induce economic change, at least not in a directly observable fashion in a paradigm of unidirectional cause and effect. Consequently, one must expect that RE would not generate sufficient additional incomes to finance the costs of such electrification. There would consequently be need to cover costs through subsidies. From the data available, rural households in South Africa do *not* form an exception in this respect.

Introduction of electricity should, consequently, be based on least-cost principles, and other supply options (in addition to electricity) also need to be considered, because electricity would need a long time to penetrate rural areas: supply is costly and the ability to pay, which initially is low, might only grow slowly and not simply because electricity has become available.

At the micro level – the level of the potential new electricity consumers – we have incomplete but wide ranging information on household expenditures on energy commodities, both for urban areas (not the scope of this paper) and rural households on commercial farming land and in South African 'homelands'. Energy expenditures in rural areas are low. If access to electricity was to be introduced on a large scale, household demand for electricity would give low initial loads. It is therefore important that RE is introduced in a manner which would look for other loads in addition to households: community institutions (schools, clinics, administrative offices etc) and local businesses, where an identifiable load would perhaps be already in place through the use of gensets. In addition, it would be crucial to plan carefully the siting of new government institutions to coincide with actual RE, keeping in mind the need for a higher initial load. The need for cross-subsidies from non-household consumers would nevertheless be crucial.

Ongoing rural electrification in South Africa

The present picture of RE in South Africa is a complicated and fragmented one. In many cases a clear definition and understanding of RE is missing. RE is still in its infancy in South Africa, with Eskom gradually becoming the most important distributor in rural areas. Eskom's key position will become even more pronounced with the ongoing take-over of supply rights in 'homeland' areas. The real rural content of Eskom's present electrification programme is estimated to be in the range of 10%-15% of the total number of new connections, well below both Eskom's own targets and the expected future requirements.

Electrification of rural centres and dense village-type settlements appears to be a trend among those distributors with an RE programme of any significant size, including electrification of local community facilities and small-scale commercial enterprises where such exist. Farmworker households on commercial farmland, on the other hand, do not appear to be a major target in Eskom's electrification programme, although it is likely that most of this household category can be electrified within acceptable cost ranges and with the active support of the farmer community.

The current structure of the electricity distribution industry in rural areas is an obstacle to a rapid and large-scale RE effort, particularly in former 'homeland' areas. Although some 'homeland' distributors are doing fairly well and operating according to financially sound practises, the general situation of distributors there

is quite bleak in financial terms. It is clear that a major restructuring of the electricity distribution industry in 'homeland' areas will take time, both because Eskom needs time to assimilate the former distributors within its own organisation and because considerable unresolved problems persist with regard to future local government organisation and responsibilities.

Altogether, the analysis of ongoing electrification in rural areas proves that a major RE programme is only possible when looked at in a long-term perspective and rooted in local involvement. It will require financially viable electricity distributors with consistent policies and approaches regarding connection of new customers and the charges to be applied for connection as well as use of electricity.

The future rural electrification framework

Based on analysis of the scope for electrification in South Africa and experiences and trends in ongoing RE efforts, a framework is recommended for future RE. This framework contains the following elements:

- The time horizon for a major RE programme should be at least 15-20 years, with initial priority being given to support the development of rural growth-points, as well as electrification of farmworker households.
- Cooperation with local community structures in electricity project formulation and planning is essential.
- Access to electricity (connections) should be subsidised, not the use of electricity.
- There should be a national straight-line tariff.
- Least-cost supply solutions should be adhered to.
- Restrictions should be placed on maximum allowed utility-financed cost per connection, but there should be opportunity for local communities to negotiate contributions or different levels of supply service in order to gain access to electricity.
- A national service cost parameter must be established.
- The government must commit and sustain subsidies (capital transfers) to the utility under a contract plan arrangement.
- There must be a specific RE government budget line item in order to influence the RE priorities of utilities and increase the RE tempo.
- While the electricity distribution industry gets restructured, efficient local distributors and Eskom should be allowed to go into areas (through negotiated take-overs or cooperative arrangements) where they have no formal supply rights.
- In order for sufficient loads to be built up more quickly, a RE programme should also identify unelectrified social (and other) institutions in rural areas with an identifiable load.

Scenarios for rural electrification in South Africa

Future RE in South Africa has been analysed in the form of two scenarios developed by the EPRET project for the overall electrification in South Africa: the business as usual (BAU) scenario and the integrated energy planning (IEP) scenario. The BAU scenario is based on the assumption that future electrification closely resembles present activity levels and priorities, while the IEP scenario is a more ambitious

one, both with regard to the overall number of new connections and an increased focus on rural areas.

The two scenarios are based on a common set of demographic assumptions as well as common assumptions about consumption levels, connection cost for each household category, bulk supply cost, fixed service cost per consumer, technical and non-technical distribution losses, capital replacement provision for the distribution network and a new national flat-rate tariff for all domestic consumers.

The BAU scenario will provide a total of about 1.2 million new connections in rural areas over the period 1994-2010. This implies that 24% of rural households will have access to electricity in 2000, increasing to 43% in 2010. The accumulated financial requirement of this RE programme will reach R7 billion by 2010, measured in fixed 1993 Rand values.

In the IEP scenario RE proceeds more rapidly, with the help of a restructuring of the distribution industry, harmonisation of domestic tariffs for both existing and new customers and the fact that government financial support for electrification is forthcoming. The total number of new rural connections in this scenario will amount to about 2.2 million over the 1994-2010 period, almost 90% more than in the BAU scenario. Household access to electricity will reach 43% in 2000 and 76% in 2010. This must be regarded a very ambitious RE programme.

The accumulated financial requirement of the RE programme in the IEP scenario will reach R14 billion (in 1993 value of money) by 2010, of which R11 billion is accumulated capital expenditure and about R3 billion accumulated operating deficits. Due to low consumption levels and high service costs, the operating deficit is expected to continue also after 2010.

One of the major problems with a comprehensive RE programme is high and increasing connection costs for new customers. If a national connection cost parameter of maximum R3 000 per new connection was applied, the total accumulated financial requirement would be R6.5 billion over the programme period, about R4.5 billion lower than if expected real connection costs are applied for the new rural connections. These extra costs should not be imposed on the electricity distribution industry, but must be covered from other sources. Potential sources discussed in the paper are the introduction of a special government tax in the form of an electrification levy on total electricity generation in South Africa, direct government contribution in the form of budget allocations and use of local material and labour to reduce the cost of new connections.

The electrification programme discussed in the IEP scenario was not based on any detailed analysis of actual plans or capacities in the existing electricity distribution industry. It is, however, interesting to compare the programme with whatever plans exist in the industry.

Electrification of farmworker households will mainly become a task for Eskom as the organisation controls the supply rights in virtually all areas with commercial farm land. Eskom's present activity in this area indicates an annual number of farmworker connections of between 15 000 and 20 000. This is less than half of what is discussed in the IEP scenario. However, taking into account the rather favourable capital expenditure level for this type of connection, there appear to be possibilities for increasing the present activity in this sector quite rapidly. Consequently, farmworker electrification of a magnitude discussed in the IEP scenario might be achievable, given the necessary priority by Eskom and the new government.

A programme for electrification of predominantly poor households in the 'home-land' areas is much more complicated. The fragmented structure of the electricity distribution industry, poor local infrastructure, uncertainties about future local government organisation and finances etc make electrification in these areas a

considerable challenge. Furthermore, the actual planning of electrification programmes in these areas is still at a rudimentary stage.

Based on information from Eskom and the various 'homeland' electricity authorities, it is estimated that somewhere between 250 000 and 300 000 new rural connections are planned in the 'homeland' areas for the period up to 1998. The assumed number of rural connections in the IEP scenario for the same period (excluding connection of farmworker dwellings) is about 325 000. Hence, if the authorities could manage to comply with their plans, a considerable number of new connections would be made in the 'homeland' areas.

There is, however, reason to question the number of new connections planned in some of these areas. The plans for Bophuthatswana, Gazankulu, KaNgwane, Qwaqwa and Venda appear realistic, while those presented by Ciskei, KwaNdebele, Lebowa and Transkei appear unrealistically high, taking into account the present situation of electricity distribution in these homeland areas. The future for a major electrification programme for rural households in 'homeland' areas seems very uncertain, due to problems related to local government structures and the required restructuring of the electricity distribution industry.

Having analysed the financial implications of a major RE programme as set out in the IEP scenario, it is obvious that the costs of a programme aimed at providing electricity to about 75% of the rural population by 2010 will be high. It has, on the other hand, been demonstrated that the programme can be financed by a combination of cross-subsidies from other consumer groups, the introduction of an electrification levy on generation, and a limited extra direct government contribution over the national budget.

Investing R11 billion in providing *access* to electricity in rural areas and covering another R3 billion in operating losses – a total financial obligation of about R14 billion (in 1993 prices) – must, however, be carefully weighed against the priority needs of the rural households and possible alternative use of resources for rural development.

Important problem areas for a major RE programme are the widely differing practices with regard to connection policies and connection fees charged to customers, tariffs charged for rural electricity supply, and government policy for subsidising electrification. This is, in fact, a subsidy benefitting existing consumers more than new consumers and, as such, not equitable when discussing household access to electricity.

The scenario analyses in this paper focus only on the financial implications of a major RE programme. Even if a major RE programme is not directly financially viable, it might be worth while undertaking when evaluated in a socio-economic context. It has not been possible to include a cost-benefit analysis of the RE programme in this paper, but it is strongly recommended that such an analysis be carried out as a priority task.

Policy recommendations

The following recommendations are proposed for implementation at the policy level to foster a sustainable development of RE in the new South Africa:

- i) Rural electrification must be linked to a national policy for rural development in South Africa, consistent with current and expected future budgetary constraints.
- ii) Rural development policies must be based on genuine local needs and local participation in programme planning and implementation. The service level

of electricity provision in rural areas should be carefully weighed against the electricity needs of the rural population within the framework of integrated energy planning.

- iii) A national electrification programme must be designed with a balance between electrification of urban and rural areas. The government has a special role in fostering a more equitable access to electricity in rural areas, and might wish to introduce an electrification levy in order to facilitate redistribution of the sector's financial surpluses to assist in financing rural households' access to electricity.
- iv) The government should as soon as possible develop a national rural electrification policy. An RE programme and action plan should be developed, based on a contract plan relationship between the government and the electricity distribution industry. The plan should have a defined long-term time horizon and contain information about financial and other commitments to rural development programmes of each of the parties involved. The action plan must be based on a clear understanding of how to rank and prioritise RE projects and have monitorable targets as to how many, where and at what cost RE should be carried out.
- v) Government policy, programmes and plans must be based on the principle of least-cost electricity supply solution, including both grid and non-grid developments of electricity provision in rural areas.
- vi) The national RE programme should not be in conflict with the principle of maintaining a financial viable electricity distribution industry. Hence, a capital contribution per connection in rural areas should be provided by the government to the industry to cover connection costs above a certain national level. It is recommended that the government for each year of the programme period allocates a specific amount as a line item on its annual budgets in support of RE.
- vii) The tariff charged for electricity in rural areas shall be equal to a national (possibly at a later stage regional) straight-line household electricity tariff, based on the principle of a straight-line tariff, implying a cross-subsidy from domestic consumers with higher average consumption levels to consumers in, for example, rural areas.
- viii) The RE programme should initially aim at electrification of rural 'growth centres' with an identified socio-economic potential and possible establishment of productive activities.
- ix) The national RE programme should emphasise electrification of farmworker households, but must, from the outset, also pay serious attention to electrification of households in rural dense and rural scattered areas.

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Introduction

1.1 Rural electrification in the political debate in South Africa

South Africa is presently in a critical phase with regard to a political settlement for the future. Electrification of predominantly poor households, both in urban and rural areas, is assumed to be a key part of a short-term redistributive investment programme of an interim government, and probably for any government for the required time-horizon, to redress socially unacceptable imbalances in access to important public services such as electricity supply. It is important to understand that underprivileged peoples of South Africa consider access to electricity a *symbol* of rights previously denied them. By South Africa is meant the combined territory occupied by the present Republic of South Africa (RSA) and that of the six self governing territories (SGTs) and Transkei, Bophuthatswana, Venda and Ciskei (the TBVC states).

When discussing rural electrification it is important to make clear the distinction between urban and rural areas. South Africa has its own special characteristics, based on oscillatory migration, and a large number of households (the poor in particular) having both rural and urban bases. Firstly, in the EPRET project, households were assumed to be urban if it seemed appropriate that services, particularly energy services, could be delivered to them in the same way as commonly recognised urban areas. This also satisfied the criterion that energy usage patterns would be similar. Secondly, to satisfy the criterion of having access to meaningful statistics on aspects apart from energy usage, it was decided to use the Development Bank of Southern Africa's (DBSA's) categorisation of 'functionally urbanised' as a basis for calculating the numbers of households, their geographic location, and other non-energy specific statistics. Rural households were calculated from the number of people that were 'not urban' (Trollip 1993). The total number of rural households were estimated to be about 3.2 million in 1990, of which 0.9 million were rural farmworker households on commercial farm lands and 2.3 million households in 'homeland' areas in the SGTs and the TBVC states.

While national household formation between 1990 and 2010 is expected to be about 2.5 million households, the number of rural households on a national level is *not* expected to change much. Certain regional changes will, however, most certainly take place, with the number of rural households growing in some regions and decreasing in others.

Rural areas in South Africa are characterised by severe poverty, low productivity and limited access to land, gainful employment, or public services. This is true both in homeland areas (the TBVC states and the SGTs) and for rural areas of RSA, the latter consisting mainly of farmworker households on commercial farms. Rural development is a complex and difficult process which requires well-conceived and integrated policy interventions. There are many constraints to sustained rural development, amongst which is inadequate energy supply.

The electrification of the homes of the poor is becoming an increasingly important issue within development debates in South Africa. Presently, progress is being made to electrify the homes of hundreds of thousands of South Africans who were previously denied access as a result of the racially-based structure of the electricity supply industry. Yet most of this progress is being made in urban areas, and many difficult and unresolved questions arise in the rural context, in particular with respect to ability to pay for both *access* to and *use* of electricity.

It is assumed that a new democratic government will remain firmly committed to a programme of redistributive investments in rural areas, including the rapid improvement of levels of service provision. As rural electrification (RE) is costly (compared to similar urban electrification and probably also to the supply of alternative forms of energy, such as gas and paraffin), it is clear that careful consideration has to be given to developing a clear *framework* for an integrated RE programme for South Africa and its concomitant tempo of implementation and required financing.

1.2 Purpose of paper

The purpose of this paper is to analyse the situation surrounding RE in the 'new' South Africa from a largely financial perspective, by setting out guidelines for a major RE programme. In doing so, the paper will examine necessary socio-economic (inter alia ability and willingness to pay) and financial preconditions for a comprehensive RE programme to be successfully implemented. More specifically, the principal objectives of the paper are to:

- consider briefly possible links between RE and rural development or vice versa;
- discuss the scope for electrification in South Africa (rural, peri-urban and urban);
- describe ongoing electrification in rural areas in South Africa;
- state the framework (financial and otherwise) for future South African electrification;
- develop and analyse scenarios for RE in South Africa;
- derive conclusions, guidelines and recommendations for a sustainable South African RE programme.

The paper does *not*, however, take side in the ongoing debate about the size and tempo of a RE programme. On the other hand, the paper points out inherent goal conflicts in attempting to raise the living standards of the South African poor on a wide front and within a short period of time.

The paper does not address the issues of electricity generation, methods of shifting peak demand, and spreading loads. It is accepted that the current generation capacity excess is sufficient to remove it from the RE debate. It is, however, acknowledged that, as the economy grows and electrification expands, it will become an issue in the next century.

1.3 Approach

This paper on RE is one of several papers forming a rural cluster in the South African Energy Policy Research and Training (EPRET) project at the University of Cape Town. Paper 6 on *Energy for rural development* (Thom 1993) takes on the task of integrating the policy options for the provision of energy to rural areas, while Paper 7 on *Energy and small-scale agriculture* (Auerbach & Gandar 1993) is considering energy strategies to support the growth of small-scale black agriculture, especially in and around 'homeland' areas. The situation in these areas is further elaborated in paper 8A on *Energy supply options in homeland areas* (Khosa 1993). Only about 3% to 4% of households in these areas have access to electricity, and a majority of households use fuelwood as main source of energy. Strategies being examined include the improved supply of fuelwood, fuel-switching to paraffin, coal and gas, and electrification. The situation for rural households outside homeland areas is

examined in Paper 8B on *Energy consumption patterns and supply options for farm-worker households* (Hofmeyr 1993), where attention is given to improving energy supply for farm labourers and their families in the commercial farming sector in the present RSA, with a particular focus on the relationship between energy supply options and the reduction of farmworkers' total dependence on farmer-employers as monopoly supplier also of services like housing and energy like fuelwood.

Outside of the rural cluster of papers itself, the work on RE is closely linked to some other cross-sectorial areas of the EPRET project, the most important ones being work on establishing a data base for household income and expenditure patterns, including information on energy demand and usage patterns in under-developed urban and rural areas (Trollip 1993), work on the future organisation of the electricity distribution industry in South Africa (Paper 14A, Steyn 1993), financing and economic implications of household energy supply policies (Paper 18, Van Horen 1993) and household energy pricing policies (Paper 19, Pickering 1993).

This paper aims to integrate the original research referred to above with regards to RE, and derive *consistent* descriptions and scenario analyses of financial implications (for utility, government and consumer) of alternative approaches to a South African RE programme. In particular, analyses inter alia test out implications for a feasible RE (RE) programme of:

- alternative initial allocations of the electricity supply industry's operating surpluses, through different levels of cross-subsidies and assumptions on real developments of household electricity tariffs;
- the effect of rising medium-term (5-10 years) and long-term electricity supply costs;
- the effects of alternative approaches to RE planning (for example initial targeting of 'rural centres' versus 'district by district') on electricity supply costs *and* on intra-rural and rural-urban migration;
- alternative lengths of duration of an RE programme;
- alternative levels of government budget allocations to RE.

In discussing future scenarios for RE in South Africa, the analysis will build on a financial model developed by Van Horen (1993) under the EPRET project, for analysis of the overall financial implications of a comprehensive household electrification programme (urban and rural) for the 'new' South Africa. However, the RE scenario discussion in this paper will include more detailed analysis of RE in the various parts of South Africa.

If the analysis and conclusions that result are felt to be somewhat cautious, this is a result of the financial focus of the discussion that must work within the country's current limits and the constraints they impose, not from a lack of enthusiasm for the importance of RE in South Africa.

Rural electrification and rural development

2.1 Energy and sustainable rural development

For a stable rural population to sustain itself on a limited expanse of land would require use of natural resources in a sustainable manner. This would mean that all natural systems, including biomass resources, need to be maintained through balancing human-induced off-take against natural growth, that water resources be maintained, that the agricultural mode of production would not promote the destruction of the soil itself, etc. Were the rural population to expand beyond this, negative environmental implications would follow, such as increasing deforestation and soil erosion, lack of water. Such developments might to some extent be contained through social and technical innovations, reduced natural increase of population and net emigration.

Imports of new energy commodities could be an example of a technical innovation, but for which there must somehow be created an ability to pay. The introduction and sustained use of electricity in rural areas, even if access costs were to be subsidised from outside, would require new kinds of incomes or reduction in expenditure on other goods. Therefore, introduction of external energy commodities, and indeed all new goods imported into an area, can best be sustained through induced growth of (new) economic activities to finance the imports.

It should be recognised that *energy fuels, other than for example grid electricity*, will probably be central to rural households for a long time, while a rural electrification (RE) programme gets implemented. For instance, in the Republic of China (Taiwan 1991: Table 2) it took about 15 years (1954-1968) to electrify 80% of rural households. Therefore, rural energy policies must ensure that such other fuels would be generally accessible to rural people. A RE programme which probably would take a long time to really make a difference to the rural energy consumption mix, cannot be an alternative to an 'other fuels programme' (cf. Thom 1993: Ch. 5).

2.2 Rural energy supply options

The rural population in South Africa is found on the land of commercial farmers (900 000 farmworker households) and 2.3 million households in the homelands (including Transkei, Bophuthatswana, Venda and Ciskei). From the EPRET Database (Version 1, September 1993) energy expenditure patterns for the South African homelands have been extracted in Table 2.1.

In the EPRET Database (Version 1) there is very little information on expenditure on batteries. It is assumed that candles, paraffin and batteries constitute energy commodities which will be gradually, perhaps substantially, reduced in importance with the introduction of electricity. The lack of information on household expenditure on batteries therefore means that we miss an important piece of information in the puzzle that would constitute the first stage of *transition* to the use of electricity for lighting, media and some cooking. Assuming for sake of argument that the expenditure on candles and paraffin (between R9 and 29 per month) would be fully shifted on to electricity, this would only allow for an expenditure level for electricity of between 39 and 127 kWh/month (assuming a tariff of 23 c/kWh). If the level of expenditure on batteries in Gazankulu provides an indication, we could increase the number of kWh used by about 50%, comfort-

Area	Coal	Candles	Gas	Paraffin	Wood	Elec.	Batteries ²
Transkei	2.59	2.89	1.50	11.50	16.20	0	n.a.
Bop'tswana	1.59	5.92	1.82	14.63	6.00	0	n.a.
Venda ³	1.83	5.64	9.42	15.10	11.80	0	n.a.
Ciskei	0	0.68	0	11.40	19.13	0	n.a.
Gazankulu	1.83	5.64	9.42	15.10	11.80	0	10.97
Kangwane	0.56	3.81	0	5.63	18.00	0	n.a.
KwaNdebele	6.94	5.73	5.18	23.74	6.73	0	n.a.
KwaZulu ⁴	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Lebowa	0.55	3.31	0	5.63	18.00	0	n.a.
Qwaqwa	27.07	5.47	2.15	12.11	5.14	0	n.a.

Notes:

1. Sources are numerous studies from the last 12-15 years. Expenditure has been adjusted to 1990 prices.
2. Information on batteries will be fully included in the EPRET Database Version 2.
3. No household energy studies for Venda have been found for incorporation into the EPRET Database (Version 1, September 1993). As a proxy average data from Gazankulu have been used.
4. Not available – n.a.

TABLE 2.1 Monthly rural household energy expenditure in South African 'homelands'. Rands in 1990 prices⁽¹⁾

Source: EPRET Database Version 1, UCT, September 1993

ably in line with EPRET's scenario assumption on initial monthly kWh consumption of rural households of 60 kWh. Of course, not all expenditure on paraffin, candles and batteries would be shifted to electricity. Hence, expenditure levels mentioned above would not alone be sufficient to pay for electricity unless expenditure on other commodities is reduced.

Although some electricity is being used among households in rural areas of the South African homelands, the information recorded in the EPRET database shows only insignificant amounts. The picture emerging (see concluding remarks in section 2.1) is of a multiple-fuel economy in slow transition.

More or less the same energy use picture also applies to the farmworker households (see Hofmeyr 1993: Ch. 3). There is, however, one large difference in their situation: about 15% of farmworker households already have access to electricity through their employers, with an average monthly consumption estimated at about 200 kWh (Hofmeyr 1993: Chapter 3.3.3). Because a majority of farmworker households live on farms that have been electrified, it is expected that the average cost of connecting these households to grid electricity will be generally lower than for rural households in the homeland areas. Therefore, when it comes to rural energy supply options, farmworkers could probably be connected to *grid electricity* much more rapidly than rural households in the 'homelands', because there are fewer farmworker households, and because the basic supply infrastructure in many cases is already nearby.

Many farmworker households (about 380 000, according to Hofmeyr 1993: Ch. 4.4) work and live on farms either without grid electricity or requiring cable runs of more than 4 km from the employer's house. Hence, *off-grid supply options* would have to be considered in a large number of cases.

PV-systems require a high initial capital outlay. For this reason it is expected to be outside the financial reach of most farmworker households were they without any

special financial assistance. Eskom has, however, designed a special R-tariff (Remote Area Power Supply tariff) for PV-systems, which would require a payment of R65/month for a supply of 100 Wh/day, excluding battery replacement costs. According to Hofmeyr (1993: Ch. 2), the mean monthly cash wage of farmworkers is R378. Hence the R-tariff seems high in relation to farmworkers' incomes and other required energy expenses.

When it comes to *batteries*, these are widely used and are expensive regardless of access (Hofmeyr 1993: Ch. 4.4.2). Hofmeyr also points out that:

There is probably scope for rationalised on-farm battery charging facilities (both on electrified farms and off-grid farms operating diesel generators). User information about optimal battery selection and use could be of supplementary benefit'.

With regard to *gensets*, Hofmeyr (1993: Ch. 4.4.3) concludes that: 'Few farmworkers are likely to operate diesel generators, due to fairly high initial costs, and high operating and maintenance costs'. When it comes to small petrol generators, Hofmeyr's conclusion is the same: although initial costs are lower, the running and maintenance costs of such generators are much higher. What has been said above about initial costs would also apply to *windgenerators* and *solar water-heaters*.

When it comes to *fuelwood* supply options, Hofmeyr (1993: Ch. 4.5.2) notes that: 'Despite abundant on-farm resources of fuelwood, there are clearly areas where workers experience shortages.' The solution she suggests would be to improve farmworkers' access to fuelwood on their employer's farm through improving current resource utilisation (better management of natural woodlands, and controlling and harvesting of invasive species) and through a multipurpose tree-growing programme.

Regarding supply options for *other fuels (candles, paraffin and LPG)*, the problems identified (Hofmeyr 1993: Ch. 4.6.1) are high prices at local shops, and problems with lack of transport. The supply options identified would be for the farmworkers to obtain access to a larger supplier of such fuels or to secure a better distribution system (to farmworkers). Farmers, and their organisations, might assist in extending their own rural area delivery systems also to reach farmworkers. According to Hofmeyr (1993: loc. cit.): 'Diesel is currently delivered by bulk carriers to farms; these deliveries could in future include paraffin and LPG on the same truck.'

When it comes to *supply options for coal*, Hofmeyr (1993: Ch. 4.6.2) notes that this is a fuel little used by farmworkers and 'its use appears to be concentrated around areas of coal mining'. From the point of view of reducing harmful emissions within the dwelling, the appropriate supply intervention would possibly be to replace the use of (natural) coal with a low smoke coal variety, as well as improved stove design.

What has been said above also, to some extent, applies to rural households in the SA homelands. There are, however, differences. The access to electricity, at least initially, is more limited than for farmworker households. The costs of connection will probably on the average be much higher, as there would normally be little or no initial basic supply infrastructure to build on. When it comes to supply options for fuelwood, there is a supply deficit in the South African homelands that has to be made up, through, for example, 'imports' from commercial farms in the RSA, or through better management of existing woodlands and the introduction of multipurpose tree-growing programmes.

When considering energy supply options, the financial direct cost is but one factor in the equation. The household's choice, social ramifications, and environmental externalities – locally, nationally and globally – must be considered. There is no attempt to quantify these indirect costs, but their importance should be noted, if the future development of South Africa is to be in any way sustainable.

2.3 The role of electrification in the rural context

An important question is: what could create sustainable rural development activities which would allow for a financially sustainable introduction of electricity? Perhaps the act of supplying electricity would facilitate the creation of required new development activities; perhaps not. RE will probably not cause development, but can accelerate it in the right receptive context. We believe that an integral part of such a context lies in integrating various developmental elements. It should not be forgotten, however, that successful rural development would require natural resources, capital, power, skilled and unskilled labour. The availability of one factor alone would not be enough.

Some suggestions on how to improve rural incomes, and thereby social and economic development, in South Africa have been provided by Thom (1993: Ch 2):

- meet basic services (access to water, energy,¹ health, education);
- provide food security;
- develop small-scale 'black' agriculture;
- provide basic goods (building materials, small scale agricultural implements and inputs, fuels like paraffin, candles and batteries);
- improve management and utilisation of natural resources (such as the tenure of trees);
- develop institutional and organisational capacity;
- develop appropriate local government.

The successful introduction of grid or stand-alone electricity in a rural area would have to find its place and appropriate timing as part of a widely-based development-oriented programme, in which it would be necessary to coordinate and integrate the activities and programmes of a good many institutions. At present, it is not quite clear who would be the organiser(s) and coordinator(s) of rural development. As a general principle, it is suggested that practical implementation must take place in a close dialogue with the people concerned, and that legitimate local government (directly elected district councils) would have an important role to play.

According to Thom (1993: Ch. 5.2), the main obstacle to the electrification of rural areas is the high cost of connections to the grid (or the installation of remote area power supply (RAPS) systems), as well as the continued operation and maintenance of connections and systems, as compared to the costs in urban areas. The situation is compounded by the fact that poor households (rural and urban) are generally not expected to consume sufficient units of electricity per month in the short term to enable the utility to recover the costs involved within a reasonable period. For these reasons RE is not feasible without extensive financing from resources *other than* the actual 'rural revenue base' – the rural consumer.

The current situation with regard to RE is characterised by very limited access by rural households. Where access to electricity exists, this is usually skewed in favour of the few more affluent or particular constituencies – for example, commercial (white) farmers, who at an earlier stage received considerable subsidies in order to electrify their farms. In areas where electricity has been made available to a larger number of poor rural households in the homeland areas, as in Gazankulu, the projects generally turn out not to be *financially viable* and therefore not self-sustainable over time.

This does not mean that RE would not be *economically (socially) viable*, and that a subsidisation of consumption might not be called for as well. If one were to adjust (using shadow prices) the costs of RE (increasing the cost, for example, of imported components, reducing the costs of manual labour and adding economic benefits like the consumers' surplus of being able to use a high quality fuel like electricity instead of inferior and more expensive fuels), one might well end up with economi-

1. Thom (1993: Ch. 2) argues that while energy is not a basic need, it is nevertheless crucial in the satisfaction of basic needs like food preparation, space heating and water pumping. While energy indirectly could be considered basic, there is some doubt about electricity in this respect for the following reason: While there is no clear alternative to access to a reliable source of potable water for survival, there are numerous energy alternatives to electricity. One cannot, though, avoid the *quality* aspect of basic needs services. Electricity can certainly improve the quality of life. Whether or not to include electricity as a basic need depends on one's perspective of human development requirements. Ultimately one must ask what are the financial resources available to uplift human life on a broad front (health, housing, education water and energy); and what would be the best supply combination of such services.

cally viable RE projects. However, when we consider a programme to electrify about 6.5 million households in urban and rural areas (of which about 1.9 million are in rural areas alone) over 17 years (EPRET's planning horizon), very large distortions in the allocation of resources might occur. The financial requirements of the proposed 17 years' *rural programme* alone would be substantial – approximately R11 billion in capital costs and about R3 billion in accumulated operating deficits from rural operations (cf chapter 6). The allocation losses of capital outlays of such magnitudes depend on what such amounts might have 'earned' in alternative investments in social capital: in education, in housing, in health facilities for the same rural target groups. Hence, socio-economic costs and benefits of an electrification programme would not easily be quantifiable. The World Bank (1992) has commented, concerning a possible household electrification programme in South Africa, that 'no comparative assessment has been made of the economic and social benefits of household electrification vis-a-vis investments in other basic social services, for example housing, water supply, sewerage, health, education or roads.'

When a RE programme is considered, in spite of this, an important question is: what would be the aim of the programme which would require substantial capital subsidies per connection? Should consumption also be subsidised, and what would the tariffs have to look like?. Should electricity be brought to all rural households irrespective of cost? And, over which time horizon should the programme run?

The objective of the EPRET project is 'widening access to basic energy services for the urban and rural poor'. 'Widening access to electricity' implies making available the *choice* to poor consumers, for instance in rural areas, to use electricity. If they should so choose, a normal tariff would apply. To make it possible to choose electricity, the infrastructure must be brought to the consumers' houses. Substantial cross-subsidies, from other consumer groups as well as from the government, would be required. The time-horizon of a programme would depend on financial resources being available, on the *planning capacity* of the electricity industry to prepare and undertake the actual field implementation, and, to a lesser extent, on bottlenecks in industry to supply the required materials – treated wooden poles in particular.

When electricity is introduced into a rural area, its expected initial household consumption would be for lighting, for the use of radios, and for light cooking. This would create a clear household welfare gain, because it would release time for potential gainful use at night, etc. Some time gains would perhaps also be made through a reduced need for gathering of fuelwood. The extent of the latter welfare gains would depend on how cooking would be undertaken after the introduction of electricity. This would, inter alia, depend on factors like income being available both for the purchase of electricity and for electrical appliances. Consequently, the big question would be how to 'finance' the use of the new commodity electricity. Savings on the use of other imported energy commodities, like paraffin, candles and batteries, would only partially be able to sustain loads required for large-scale RE to be financially sustainable. Important questions which require answers would be how to create (new) rural earning-opportunities through the introduction and use of electricity, how to identify rural centres for electrification, which have or are about to have community institutions (schools, clinics, community centres, public service offices, street-lighting, etc) to assist in establishing a sustainable load. The financing of electrification of such community facilities falls outside the EPRET's costing of a programme of electrification of the poor. The approach of the Independent Development Trust (Viljoen & Cross 1993: 11) is an example of how the financing of electrification of these institutions might be carried out. In the future it is expected that such costs would be reflected in the respective government department budgets.

When it comes to the actual electricity choice between grid and off-grid electricity supply (see also Ch. 2.2 above), it must be the *least-cost principle* which must be the

overall guiding principle. Foley (1990: 154) draws the following conclusions:

- The development of off-grid generating options should not be based solely on renewable technologies; these should always be compared with the alternative of using diesel or petrol and only used if they provide a better solution.
- Off-grid supply systems, whatever the technology used, should be designed as complete technical packages containing all the components and ancillary equipment required for installation and operation. They should be subjected to rigorous field testing before being made available to local communities.
- Local communities should be provided with full and unbiased information on the generation options to them.

2.4 RE and rural development: summary

Human activity, be it in urban or rural settings, is dependent on energy. Each mode of production, agrarian or industrial, and the derived role of households within them, has its own energy needs. When fuel requirements change on account of new economic activities, the supply of energy comes under pressure to adapt to satisfy new needs. That the introduction of new forms of energy in itself would lead to or induce economic change is unlikely, at least in a directly observable fashion in a paradigm of unidirectional cause and effect. Consequently, one must expect that RE would not generate sufficient additional income to finance the costs of such electrification. There would, consequently, be need to cover costs through subsidies. From the data available, rural households in South Africa do *not* form an exception in this respect.

Introduction of electricity should, consequently, be based on least-cost principles, and other supply options in addition to electricity also need to be considered. This is because electricity would need a long time to penetrate rural areas: supply is costly, and the ability to pay – which is initially low – might grow only slowly, and not simply because electricity has become available.

The way electricity is introduced is important; there would be a need to look for additional load to carry the costs of electricity supply. Such additional loads might be found through electrification of community institutions like schools and clinics, as well as the local shop and other places which would have identifiable loads. Searching for additional loads to improve the viability of RE must not be done at the expense of energy efficiency. There is a danger of supplying inefficient end-use appliances to poor people simply to increase tariff revenue. In the long term, this significantly increases consumer costs, and increases utility costs through the future need for increased generation capacity. Energy efficiency must be a priority, even with excess capacity available.

The scope for electrification in the 'new' South Africa

3.1 Access and use of electricity – the present situation

The EPRET project has found that about 37% of all households in South Africa (including the TBVC states and the SGTs) had access to electricity in 1990. Access was however, very different for various race groups, household types and for different parts of the country.

Close to all 'white' dwellings were electrified, apart from a limited number of commercial farms in very remote areas of the country. 'Black' dwellings, both in urban, but even more so in rural areas, had on the other hand very little access to electricity. Table 3.1 below presents data on the access to electricity for eight different household types analysed in the EPRET project

Household type	No. of households (in 1990)	Access to electricity (%)
Formal mid-to-high income	2 100 000	100
Formal low income	800 000	50
Informal planned shack	500 000	0
Informal unplanned shack	400 000	0
Backyard shack ¹	600 000	20
Farmworker household ²	900 000	15
Rural dense ³	1 150 000	4
Rural scattered ³	1 150 000	1
TOTAL	7 600 000	37 ⁴

Notes:

1. The 120 000 backyard shacks with access to electricity are shacks with an unapproved, non-metered connection. It will be a target for a major electrification programme to convert these to metered supply.
2. The estimate of 15% of farmworker households having access to electricity is based on Hofmeyr (1993) which finds that 22% of all farmworker dwellings have access to electricity. Taking into account that the number of dwellings is only about 65% of the total number of farmworker households, it is estimated that about 15% of all farmworker households have access to electricity.
3. The number of households in rural areas with access to electricity is based on Eskom figures, while the distribution of rural households between dense and scattered areas is a rough estimate made by the EPRET project given the lack of more detailed data.
4. Weighted average.

TABLE 3.1 Access to electricity in 1990 by household type
Source: EPRET Household Database (1993)

Table 3.2 below presents the situation with regard to access to electricity for the various DBSA development regions. These figures come from a study made by Boutek (CSIR 1991), but includes only the RSA parts of each development region while data for the TBVC states and SGTs are missing. A total number of about 2.2 million households were reported to be electrified. Access to electricity is highest in Western Cape, Natal and the PWV area, while the Northern Transvaal by far is the development region with lowest access. In addition to the electrified households in RSA, the Boutek study reported that a further 304 000 households in TBVCs (55 000), SGTs (154 000), RSA farms (63 000) and development trust areas (32 000) had access to electricity.

Region No.	Region name	% of all households electrified	% of urban households electrified
A	Western Cape	67	79
B	Northern Cape	32	43
C	Orange Free State	26	42
D	Eastern Cape	35	41
E	Natal	56	72
F	Eastern Transvaal	21	40
G	Northern Transvaal	8	10
H	PWV	54	57
J	Western Transvaal	23	35

TABLE 3.2 Access to electricity in 1990 by development region (RSA only)

Source: Boutek (CSIR 1991)

Eskom has for a number of years prepared statistics for the situation of electrification in South Africa. Table 3.3 presents a comparison between Eskom's figures for 1990 and 1993. The 1990 figures were quite similar to the figures reported by the Boutek study which was undertaken on behalf of Eskom, but included an additional number of houses not accounted for in the Boutek study. Eskom's figures are broken down by dwelling types, but using a different and less disaggregated breakdown than the EPRET project (refer table 3.1 above). It should also be noted that Eskom operates with a smaller number of dwellings than the number of households used in the EPRET project, particularly when it comes to the number of dwellings on commercial farms in RSA. Both Eskom and EPRET estimated that about 2.7 million households had access to electricity in 1990, a figure which, according to Eskom, had increased to about 3 million by the middle of 1993 due to the recent electrification efforts undertaken by Eskom and some other major municipal distributors.

Dwelling category	1990		1993	
	No. of dwellings	% electrified	No. of dwellings	% electrified
RSA metro areas	2 139 000	80	2 406 700	74
RSA cities % towns	1 288 000	51	1 407 500	54
SGTs	1 398 000	11	1 503 700	16
TBVC states	1 129 000	5	1 187 200	8
Dev't trust areas	85 000	38	85 000	24
Farmhouses	390 000	16	391 500	21
TOTAL	6 429 000	42 ¹	6 981 60043	431

Note

1. Weighted average.

TABLE 3.3 Estimated access to electricity by dwelling type in 1990 and July 1993

Source: Eskom (1990, 1993)

According to Eskom's statistics presented in Table 3.3, the overall situation with regard to access to electricity has not changed very much between 1990 and 1993. Due to a considerable rural-urban migration, the access to electricity in RSA metro areas has, in fact, gone down from 80% to 74%, while the situation has improved for most of the other dwelling categories used in the statistics. The exception is a considerable decrease in the access to electricity in development trust areas, despite the fact that the number of households are reported to be the same both in 1990 and

1993. This example illustrates some of the considerable uncertainties pertaining to reported figures for electricity access for various dwelling or household types. It is, however, the opinion of the authors that the quality of Eskom's data has improved over time and, hence, that the 1993 figures are more reliable than earlier estimates. As already mentioned, a major uncertainty with the 1993 (and also the 1990) figures is the low number of farmhouses reported by Eskom. Recognising the fact that more than one household might live in the same dwelling, EPRET's figure of 900 000 households has been used in the further analysis.

3.2 Scope for urban and peri-urban electrification

EPRET estimates that about 2.5 million formal houses in urban and peri-urban areas were electrified by 1990 (Trollip 1993). 2.1 million of these households were in the medium-to-high income category, with an estimated monthly consumption of about 800 kWh. The remaining 0.4 million were in the low-income group with an average monthly consumption of only 100 kWh. The low consumption level reflects both low income levels and the fact that these households were connected only quite recently. The consumption level is, however, expected to increase to about 500 kWh/month within about ten years. In addition to the above-mentioned electrified formal houses, about 0.1 million backyard shacks were estimated to have access to electricity in 1990, through illegal connection to neighbouring electrified (formal) houses.

A total of 1.9 million formal urban (and peri-urban) households were not yet electrified in 1990, although about 0.1 million might have had a form of illegal connection as mentioned above. These 1.9 million households were assumed to be distributed across four different housing types as shown in Table 3.4, also indicating estimated monthly consumption levels initially and after about ten years.

<i>Household category</i>	<i>No. of households</i>	<i>Initial/end(after 10 yrs) monthly consumption</i>
Formal low-income	400 000	100 / 500 kWh
Planned shacks	500 000	100 / 500 kWh
Unplanned shacks	400 000	80 / 200 kWh
Backyard shacks	600 000	80 / 200 kWh

TABLE 3.4 Non-electrified urban households in South Africa in 1990
Source: EPRET Household Database (1993)

The number of households in the above four categories is expected to grow from 2.3 million (figures in Table 3.4 plus 0.4 million formal low-income households already electrified) in 1990 to about 4.2 million by year 2010, presenting an even bigger challenge for an urban electrification programme. The large expected increase in household numbers is due to population growth and to an expected continued migration to urban areas. The number of households in rural areas is, on the other hand, expected to remain fairly stable.

3.3 Scope for rural electrification

Table 3.5 summarises the number of rural households as of 1990, used in the EPRET project, for each of the nine development regions commonly used by DBSA, indicating the split between households in rural RSA and rural homeland areas (the four TBVC states and the six SGTs) for each of the development regions.

Region No.	Region name	Rural RSA households	Rural 'homeland' households	Total Nos. of rural households
A	Western Cape	95 244	0	95 244
B	Northern Cape	42 612	53 517	96 129
C	Orange Free State	176 404	50 213	226 617
D	Eastern Cape	70 544	394 810	465 354
E	Natal	127 375	823 927	951 302
F	Eastern Transvaal	130 236	88 012	218 248
G	Northern Transvaal	45 872	616 780	662 652
H	PWV	95 644	168 478	264 122
J	Western Transvaal	95 021	111 120	206 141
TOTAL		878 952	2 306 857	3 185 809

TABLE 3.5 Rural households by region in South Africa in 1990
Source: EPRET Household Database (1993)

The total number of rural households in South Africa (including the SGTs and the TBVC states) is about 3.2 million, of which 3 million are without access to electricity (EPRET 1993). Information from Eskom (1993) indicates that about 85 000 households in rural settlements and some more remote rural areas already have electricity, while about 135 000 farmworker households are connected to the grid (derived from Hofmeyr 1993). Most of the latter households are not metered and billed separately, but connected via the farmer's connection. It is difficult to say how large a portion of the existing 3 million non-electrified households in the rural areas can and should be made targets for a major RE programme. This will depend on a number of issues already discussed in Chapter 2. For the purpose of the analysis of future RE in South Africa, the rural areas have been divided into two main categories: farmworkers' houses and rural households in homeland areas (including the TBVC states).

3.3.1 Farmworker electrification

According to EPRET's household database (1993) the actual number of farmworker households is about 0.9 million. This is based on a number of 1.2 million active farmworkers (CSS 1990), of which about 0.3 million belong to the same households.

The number of farmworker dwellings on commercial farms in South Africa was in 1990 estimated to be about 584 000 on 67 000 farming units (CSS agricultural statistics 1990), a considerably lower figure than the number of households estimated by EPRET (1993). Hofmeyr (1993) estimates the number of dwellings to be about 550 000 and the total size of the farmworker community approximately four million. For the purpose of discussing electrification of farmworker households (not dwellings), EPRET's household figure of 0.9 million will however, serve as the basis for the analysis in this paper.

A weighted average of seven different studies of farmworker electrification, carried out in the period 1985 to 1992, indicate that 68% of commercial farms are connected to the electricity grid and that 22% of farmworker dwellings had access to electricity. The study by Hofmeyr (1993) supports these findings, and estimates that 32% of farmworker dwellings on farms with electricity have access to electricity. Assuming that about 70% of commercial farms are connected to the grid, this supports the estimate that about 22% of farmworker dwellings are electrified. The number of electrified farmworker households are, however, lower, due to the fact that more than one household often share the same farm dwelling. A figure of 15% is estimated for the total number of farmworker households.

It is generally regarded that, in terms of quality of life and basic needs fulfilment, farmworkers see themselves as worse off than people in the rural homelands (Moller 1985). Farmworkers are traditionally remunerated with payment in kind (which puts a value on housing, food rations and support for health-care and schooling) and hence low cash wages. Cash wages differ, however, considerably with the extent of workers' skill, the value of payment in kind and the type of ownership and the profitability of the farm. Hofmeyr (1993) finds that the cash wages for farmworker households range between R60 and R2,000 per month, with the mean wage being R378. As with cash wages, housing conditions differ considerably. Less than half of farmworker dwellings have access to piped water.

Because of the lack of protective legislation and the total dependence on their employers, there is a tremendous diversity of conditions between different areas of the country and different farming activities. This applies to the worker households' access to electricity and water, average household and per capita income and support for electrification. An interesting observation by Hofmeyr (1993) is that there is a much greater difference in the extent of provision of electricity than the extent of support for providing workers with electricity. This might indicate that many farmers face economic constraints that make it a heavy burden to engage in electrification of the worker households on the farm.

Electrified dwellings mainly use electricity for lighting, while the use of electricity for cooking and heating purposes is generally low. Hence, access to electricity has little impact on fuelwood use for cooking purposes. Use of farmwaste, paraffin and candles show the most marked change as a result of electrification.

Hofmeyr (1993: 19-30) makes a number of interesting observations of relevance to a discussion of a programme for providing increased access to electricity for farmworker households:

- Electrification of farmworker dwellings is closely related to the general wealth of the geographical area (the highest degree of electrification is found in the south-west Cape and the lowest in Natal) and the nature of the farming activity (dwellings on fruit and vegetable farms and farms with timber or sugar production have higher access to electricity than livestock and cereal farms).
- While 22% of farmworker dwellings have access to electricity, only about 10% have access to appliances providing services other than lights and media.
- The cost of electrification is the most commonly reported constraint to providing workers with electricity.
- The spatial lay-out of dwellings is significant. Where dwellings are grouped for reasons of land availability and the farm homestead is closer to the worker dwellings, electrification of the latter is more likely.
- The extent of electrification has a direct correspondence with the estimated monthly farmworker household income.
- Brick houses are much more likely to be electrified and iron houses least.

Practices by farmers that affect the extent to which workers use electricity are: limits on the type of appliances households may use; restricting the number of hours per day that workers have access to electricity; limiting the number of units a household may use before they are charged; and, where pre-payment meters are installed, giving workers a monthly ration of disposable cards. When it comes to amounts of electricity consumed by those farmworker households with access to electricity and the actual cost paid for electricity, the study by Hofmeyr (1993: 24-29) provides some interesting results:

- The weighted average consumption level is quite high, at about 200

kWh/month, reflecting a rather wide range of appliances used by the households included in the study.

- The mean household income does not impact much on monthly consumption levels up to 150 kWh/month; thereafter increased consumption levels correspond with higher household income levels.
- Most farmers contribute (92% in the study by Hofmeyr) to the cost of electricity used by their workers with, on average, about 80% of the cost being paid by the farmer and 20% by the worker.
- On average, the workers spend about 4% of their income on electricity, while workers with access to a wide range of electrical appliances spend somewhat more of their income on electricity (5 to 8%).

In general terms it appears that electrification of farmworkers' houses is usually seen by the farmer in terms of a continuous process of upgrading workers' conditions rather than a purely financial operation. Benefits are most commonly stated to include improved living conditions, quality of life and environment, improved attitude to work and better relationships between farmers and workers, together with time and money savings.

The EPRET project estimates that there presently are about 600 000 households on farms *with a grid supply of electricity*, of which at least 450 000 do not have access to electricity. These represent obvious scope for any future electrification of farmworker households. At a later stage of an electrification programme, further electrification of the remaining 30% of commercial farms (including farmworker dwellings on these farms) without electricity supply should also be targeted.

3.3.2 Rural electrification in TBVC and homeland areas

EPRET estimates that the number of rural households in homeland areas (SGTs and TBVCs) was about 2.3 million in 1990 and that the number today is about the same.¹ EPRET has further estimated that about half of these households are in *dense* rural settlements, while the other half are in *scattered* locations. The distribution of the rural households between these two housing types is, however, quite uncertain due to poor data quality. Of the 2.3 million households, about 85 000 were electrified by the middle of 1993, according to information from Eskom (1993). Table 3.6 below presents a status for present electrification in each of the TBVC states and the SGTs. The figures are based on information from Eskom and might differ somewhat from information reported from other sources.

Some comments should be made about the figures in Table 3.6. First, it is quite evident that considerable differences exist with regard to electrification in the various 'homeland' areas, both in urban and rural areas. Some of these differences might be due to difficulties in classification of the various types of settlements. Eskom is using four different categories of settlements for the TBVC states and SGTs: metro, town, settlement and rural. In the above table, metro and town have been assumed to constitute urban areas while settlement and rural constitute the rural households. Table 3.6 indicates that the number of rural households in the homeland areas is about 1.8 million, while DBSA and EPRET estimate higher numbers of 2.16 and 2.3 millions respectively. This might, however, be explained by an unclear distinction between town and settlement areas in Eskom's statistics.

Eskom reports that, on average, 4.8% of rural households in homeland areas have access to electricity. (Using Eskom's figures for the number of connected households, but DBSA's figures for the number of rural households would give a slightly lower figure of about 4.0%.)

Looking at rural electrification of 'homeland' areas in more detail, Eskom's figures indicate that about 1.7% of rural households in the TBVC states have access to

1. More recent information from DBSA about actual household sizes in the various SGTs and TBVC states indicates that the number of rural households in fact might be somewhat lower than the previous estimate of 2.3 million households. The previous estimate was based on population figures and an average household size of six persons. Using more accurate DBSA figures for household sizes would give a total number of rural households in homeland areas of about 2.16 million.

Area	Urban (metro & towns)		Rural (settlements & remote)	
	Households	% electr'd	Households	% electr'd
Transkei	45 700	21.9	544 300	0.2
Bophuthatswana	243 800	17.4	137 800	6.4
Venda	10 700	90.4	82 800	2.5
Ciskei	53 300	41.6	69 000	3.1
Gazankulu	12 100	66.6	115 700	1.8
Kangwane	16 500	46.8	82 900	2.7
KwaNdebele	56 300	17.4	25 400	5.1
KwaZulu	397 800	28.6	379 400	10.4
Lebowa	28 400	71.4	333 300	7.8
Qwaqwa	32 400	44.2	23 700	6.6
TOTAL TBVCs & SGTs	897 000	28.8 ¹	1 794 300	4.8 ¹

Note:

1. Weighted average.

TABLE 3.6 Status for electrification in 'homeland' areas of South Africa in 1993

Source: Eskom's national electrification planning division (1993)

electricity, with the highest figure found in Bophuthatswana and the lowest in Transkei. Considering the high costs and limited revenues from electrification of rural areas, it is interesting to observe that the financial position of the electricity utilities in these two TBVC states are very different – BECOR is a financially sound corporation while TESCOR is in a rather poor financial state.

The situation in the former SGTs is slightly more favourable than in the TBVC states when it comes to access to electricity in rural areas, mainly because of a rather high service coverage in rural areas of KwaZulu. Both Eskom (Natal) and Durban Electricity have taken over supply rights in certain areas of KwaZulu from the 'homeland' administration, with the result that electrification of both urban and rural areas have proceeded at a fairly high pace for the last few years. It should, however, be mentioned that what are regarded as rural areas in KwaZulu are often rather densely populated and, as such, in a more favourable situation with regard to electrification than many other rural areas. In total it is assumed that about 7.5% of the rural households in the SGTs have access to electricity.

The situation with regard to electricity supply in 'homeland' areas is in many cases difficult, with utilities and local distribution authorities severely crippled by lack of human, financial and sometimes also technical resources. Eskom or other major (white) distributors originally had no supply rights in the homeland areas. This situation is gradually changing with the introduction of a few joint-venture companies between Eskom and black local authorities and other cases where Eskom (and, for instance, Durban Electricity) are negotiating take-over of supply rights in 'homeland' areas. Table 3.7 indicates that situation as of mid-1993.

Area	Authority with supply right	Comments
Transkei	Tescor (plus two municipal distributors and Eskom in two towns)	Tescor has financial problems, Eskom has been approached for take-over
Bop'swana	Becor	Financially strong and well-run
Venda	Venda National Development Corporation – Electricity Department	Well-run operation, but dependent on capital subsidies
Ciskei	Department of Public Affairs	Financial problems
Gazankulu	Gezicor (50% owned by Eskom)	Problems, full Eskom take-over in the process of being completed
Kangwane	Kescor (50% owned by Eskom)	
KwaNdebele	KwaNdebele government	Eskom take-over being negotiated
KwaZulu	KwaZulu government, Eskom and Durban Electricity	Eskom in rural areas, Durban Electricity in some towns & settlements
Lebowa	Lebowa government	Eskom take-over almost completed
Qwaqwa	Department of Works	

TABLE 3.7 Electricity distributors in 'homeland' areas as of July 1993

Several of the 'homeland' distribution authorities receive financial support from Eskom for their electrification programmes. For 1993 Eskom had, for example, tentatively planned for support (either by a cash contribution per connection or reduced bulk supply tariff) of about 6 000 connections to be done by Becor, 2 500 by Kescor, 2 500 by Gezicor, 3 000 in Venda and 2 000 in KwaNdebele. This system will, of course, disappear if Eskom takes over supply rights in the various 'homeland' areas. The only 'homeland' area where Eskom does not consider taking over supply rights is in Bophuthatswana. Of the SGTs, QwaQwa is the only one where Eskom is not yet involved in one way or another. Most of the other authorities are either already negotiating with Eskom or planning to do so within the next year or two. While a fragmented electricity distribution industry in general is creating problems for implementation of major electrification programmes in South Africa (Steyn 1993), this does *not* necessarily apply to electrification of 'homeland' areas since Eskom (sometimes by default) might be charged with the full responsibility for these areas within a short time.

3.4 Consumers' ability and willingness to pay for electricity

When discussing features of a major electrification programme for poor households, particularly in rural areas, it is of major importance to analyse the ability and willingness of prospective consumers to pay for electricity supply. The consumers' ability and willingness to pay consists of several aspects related to the service they expect and actually will receive. Important elements are the cost of connection and how connection is to be paid for, the cost of use and the related service level, the availability of electrical appliances and, not least, the actual income levels of the households and their budget available for energy consumption. Each of these will be examined more closely in this section.

3.4.1 Connection cost

Farmworker households

Electrification of workers' houses on farms is done from the farmer's existing supply point. The responsibility lies with the farmer and with Eskom. The capital cost of farmhouse electrification is paid for by the farmer, the state and Eskom. Eskom presently offers four methods of supplying workers' houses with electricity. In all cases the farmer remains the Eskom customer while the workers are consumers. The four methods offered by Eskom to the farmer are illustrated in Figure 3.1. Most of the farmworker houses already electrified are connected according to method 1 or 2 in figure 3.1. This implies that they are consumers via the farmer and have no independent metering. The supply of the worker houses is only metered by the farmer's own meter. The farmer pays the total monthly electricity bill, generally at the Eskom D-tariff.

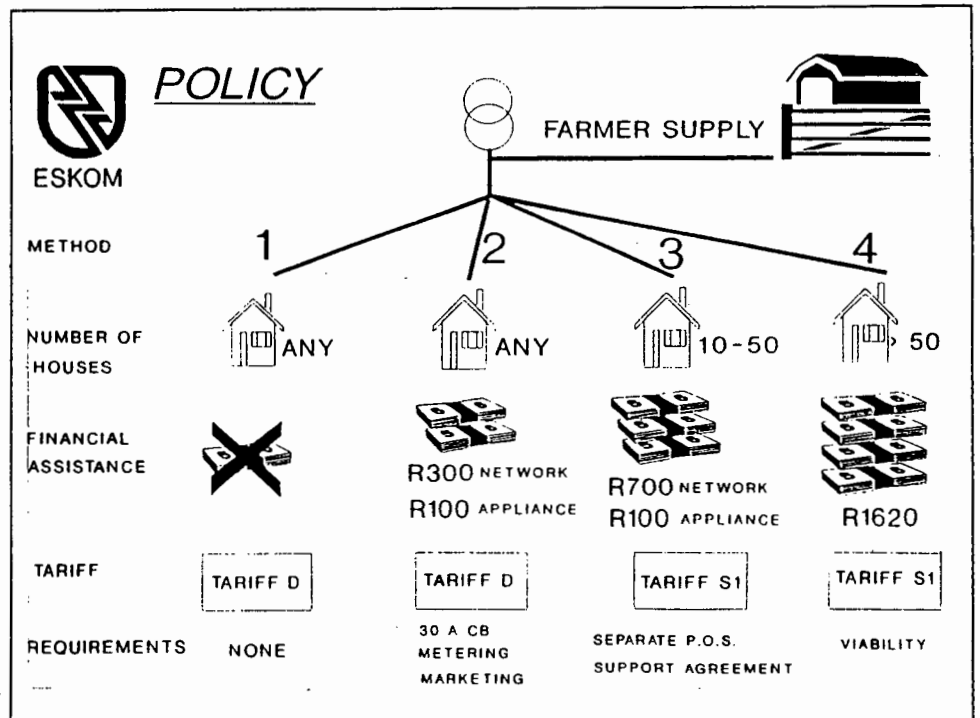


FIGURE 3.1 Electrification of farmworker houses
Source: Eskom Pricing Policy Department

Financing the initial cost of electrifying worker dwellings for method one is entirely the farmer's responsibility. For methods two, three and four, Eskom takes some of the connection costs if certain conditions are met. The state currently offers a subsidy of R300 per farmworker dwelling regardless of which of the four methods is applied, the initial cost of supplying electricity, or the level of service provided.

In the future it is assumed that most of the worker houses will be connected with ready board and pre-payment metering systems. This technical solution for house connection is assumed for the discussions in this paper of electrification of farmworker houses. The cost of the house installation alone with this solution is about R555 per system.

To supply electricity from the farmer's supply point, three reticulation system options are generally available: single-phase, three-phase or intermediate-voltage system, the latter implying a need for transformer(s) in order to electrify the worker houses. Which system will be suitable will depend on the number of worker dwellings to be electrified, the distance between dwellings, the distance from the dwellings to the electricity source and the level of supply to be installed. Direct single- or three-phase from the farmer's supply can be used when conditions are

such that workers can be reached at normal voltage (220 V single-phase, 380 V three-phase) without significant voltage drops. Where larger distances are to be covered, or voltage drops are too high, intermediate-voltage transmission (typically 1.9 kV single-phase or 3.3 kV three-phase) would be used, with step-up and step-down transformers at either end.

The level of supply will depend on the initial cost of the supply and the potential demand – which, again, will largely depend on the affordability of electricity and electrical appliances. Typical supply levels could be 5, 20 and 60 Amp, providing a maximum of 1, 4 and 12 kW respectively of power at any one time. A 5 Amp supply will basically cover the household's lighting and media needs, a cooling system (refrigerator) as well as one small thermal application like a kettle or single plate cooker. A 20 Amp supply will cover all the above, but also allow the household to have an independent water-heating system and a stove with an oven. It would, however, limit the number of appliances that could be used simultaneously. A 60 Amp supply will cover all of the above, normally with no limits on the number or mix of appliances that can be used.

Based on data from about 295 electrified farms with a total of 2063 worker dwellings, sorted into 444 dwelling groups on the basis of information about the spatial layout of farmworker houses obtained from a postal survey, Hofmeyr (1993) has analysed actual connection costs for electrifying the various worker dwellings. The results of the analysis should be treated with caution for several reasons, particularly since there is reason to believe that the respondents (farms) included in the analysis are likely to be those where physical and socio-economic conditions generally favour electrification of worker houses. The results of the analysis are, however, very interesting and give a good perspective of the potential costs of embarking on a programme of electrification for worker houses on farms already electrified. As such, the results of the analysis might be of relevance to a total number of about 450 000 worker dwellings not yet electrified.

Table 3.8 shows the percentage of worker houses in the Hofmeyr survey that could be connected using single- and three-phase reticulation, for different levels of supply. The remainder have been assigned to the intermediate-voltage option.

Technology	Percentage of houses		
	Level of supply		
	5 Amp	20 Amp	60 Amp
Single-phase	31	8	1
Three-phase	18	10	3
Intermediate-voltage	51	82	96

TABLE 3.8 Technology requirements for worker electrification on farms with electricity
 Source: Hofmeyr (1993: 53)

It appears that about 50% of farmworker houses on farms with electricity could be served by low-voltage reticulation if the level of supply is limited to 5 Amp per dwelling. At 20 Amp the figure drops to about 20% and, at 60 Amp, to less than 5%.

Based on these results, current information about costs and input requirements for systems and materials, and the spatial layout data from the survey, Hofmeyr (1993) has estimated the actual cost for each individual connection. This is based on the assumptions that there are no supply constraints on the farm's supply, use of underground cables, no physical obstructions to ploughing, etc, and use of available farm-labour and machinery (not contractor labour and equipment). The percentage of farmworker dwellings supplied with a 5 Amp option within particular cost ranges are summarised in Table 3.9.

Cost in 1993 Rands	Percentage of dwellings			
	Single-phase	Three-phase	Interm.-voltage	Total
700 to 1000	16	0	5	19
1001 to 1500	7	4	15	26
1501 to 2000	2	5	2	10
2001 to 2500	1	3	3	7
2501 to 3000	1	2	4	7
3001 to 3500	1	1	2	4
3501 to 4000	1	1	3	4
4001 to 4500	1		1	3
4501 to 5000			3	3
Total <5000	30	16	38	84
>5000	1	2	13	16

TABLE 3.9 Supply cost for worker dwelling with a 5 Amp electricity supply
Source: Hofmeyr (1993: 55)

For less than R5 000, using farm labour, about 84% of the dwellings can be supplied with a 5 Amp supply. The average cost for these 84% of the dwellings is in the region of R2 000 per house using farm labour and R3 000 using contract labour.

The analysis carried out by Hofmeyr presents a quite optimistic picture with regard to the initial cost per connection for a major rural electrification programme aimed at farmworker dwellings. It should be remembered that the worker houses analysed by Hofmeyr are likely to be among the easiest ones to electrify. The most expensive houses to electrify are single houses or small groups of two or three houses that are at a considerable distance from a supply point, because there are fewer houses to share the cost of cable and possibly also the cost of transformer(s). Extending the programme to farms not already connected to the electricity grid will further increase the cost per connection of such a programme.

Rural households

Connection costs for farmworker houses have been analysed in considerable detail by Hofmeyr (1993) as described above. This is, however, not the case for rural households in 'homeland' areas. Very little, and only fragmented, information and experience exist regarding electrification of these dwellings. Rural households are, furthermore, hardly a priority category in the electrification programmes presently being undertaken or planned by the electricity distribution industry. Eskom (personal communication: 1993) indicate that (considerably) less than 10% of their planned connections for the next five years are in rural areas. What is included in the rural category is mainly electrification of rural villages and some other dense rural settlements.

For those connections denominated as rural in Eskom's electrification programme, the average connection cost is presently about R4 500, with costs in the most outlying areas furthest away from the existing grid amounting to about R6 000. Electrification of truly scattered settlements in 'deep' rural areas is expected to bring the connection costs up to about R10 000 per connection. When these high capital costs are combined with higher than usual service costs, higher technical and non-technical losses on distribution and lower consumption levels than for other poor households in urban and peri-urban areas, rural electrification on a large scale appears financially unviable and very problematic for Eskom and the rest of the EDI. Eskom's figures are supported by similar, if not even higher, figures experienced by Durban Electricity Department – the second largest distributor in South

Africa – with a rather expansive electrification programme (Electricity For All – EFA) ongoing since late 1991 (cf. section 4.2.2).

When discussing policy and financial implications of a major electrification programme, EPRET has assumed that the average cost of electrifying a house in dense rural areas is about R5 000, while the average connection cost in remote rural areas is assumed to be about R7 000 (Van Horen 1993). These are quite conservatively estimated and could also be taken as *maximum* connection cost parameters to be used in prioritising a rural electrification project. In the absence of more detailed figures for various parts of rural South Africa, these connection cost parameters will be used for the analysis in this paper. It should be noted that the above figures are averages over a large number of households. At the end of a long-term electrification programme it is reasonable to expect that the connection cost will increase considerably, particularly for new connections in far outlying rural areas. Connection costs of about R10 000 should not be regarded as unrealistic for such areas. For comparison, it could be mentioned that EPRET assumes that the comparative cost parameter for connections in urban areas is R3 000.

One comment appears pertinent when discussing connection costs for new consumers. The appropriate cost to consider should be the direct marginal costs incurred for connecting each new consumer. This cost might be lower than the above figures for many of the new consumers, due to the fact that capacity expansion of the overall HV and LV distribution network will only take place in discrete steps when new transmission and transformer capacity is needed in an area. Hence, for a specific rural area where distribution facilities already exist nearby, and with a limited number of new consumers to electrify, the actual connection costs might be considerably lower than indicated by average connection cost figures. This is the problem with allocation of costs of shared facilities. When an electrification programme, however, is escalated to cover a large number of consumers spread out over large areas and over a considerable period of time, all the relevant distribution system expansion costs also need to be included in the marginal cost of the programme. Such capacity expansion costs are included in EPRET's cost estimates and distributed over a large number of new consumers.

The connection cost figures referred to above all relate to grid-supplied electricity. In remote rural areas, where grid extension will be very costly, off-grid electricity supply solutions will have to be considered, particularly RAPS solutions based on photovoltaic (PV) electricity generation. Stand-alone PV/battery systems can provide a limited supply of electricity sufficient for high-value applications like home-lighting and media. Cost estimates from the EDRC RAPS Design Manual indicate that a 200 Wh/day system can be installed for about R2 500. Recurrent running costs for such a system, including routine maintenance and battery replacements every two years, is estimated at about R23 per month. This cost is in the order of a monthly bill for a grid supply of 100 kWh/month based on the tariff level proposed by EPRET. The level of supply is, however, much lower, and PV electricity would not meet any thermal needs. If the primary value of electricity supply to the consumer is related to electric lights and media, a PV solution should be considered for such consumers. Well designed and maintained PV systems can be reliable, durable, can power high value electrical services, and should be an element in expanding the access of isolated households to the benefits of electrification.

3.4.2 Service level and cost of supply

Capacity expansion and connection costs are only part of the overall cost picture when discussing a (rural) electrification programme. In addition to up-front capital investments in distribution infrastructure, reticulation system and house connections, fixed and variable operation and maintenance costs need to be analysed in order to evaluate the financial viability of an electrification programme. A statement often heard in discussions about rural electrification is '*twice the cost and half*

the sale'. This statement reflects the fact that servicing consumers in rural areas is generally regarded as more costly than in urban areas and also that rural electricity consumers tend to use less electricity than urban consumers, due to lower income levels and different energy supply options available – such as the extensive use of 'free' fuelwood for cooking and heating in many rural areas.

The level of service consists of many dimensions, of which the most important ones are:

- quality of supply (voltage variations etc);
- interruptions (frequency and duration of outages);
- level of maintenance (response time, preventive maintenance, fault reporting etc);
- revenue collection (billing accuracy, ease of payment, availability of prepayment tokens);
- education and training (in terms of safe and efficient usage of electricity etc).

Eskom's present average fixed service costs per domestic consumer, to meet regulatory or agreed standards, are about 20R/month. This includes staff costs of running depots, maintenance costs, fault rectification and general marketing and administration in each service area. Such fixed service costs will, of course, depend on the service level to be provided to the customers – for example, the average response time in order to correct a fault situation. Due to longer distances, difficulties of access for maintenance teams, etc, service costs will usually be higher for customers in rural areas than in more dense urban areas. Eskom (personal communication: 1993) indicates that service costs in rural areas might amount to R30 per month if the same level of customer service is to be maintained. Possible solutions in order to reduce the fixed service costs are either to reduce the level (for instance limit the supply capacity per connection to 5 Amp) or quality of service, or to stimulate local community involvement in maintaining electricity systems in rural areas. The latter solution will necessarily involve some kind of training of maintenance workers at community level. A combination of the two options might be the best way of handling this issue. For the purpose of the analysis in this paper, it is assumed that a national service cost parameter of R20 per month will also apply in rural areas, without specifying in detail how this figure will be achieved.

Variable supply costs will differ between urban and rural areas, even if the actual supply cost (paid to Eskom's transmission group) is the same. Due to longer distances and weaker supply systems, distribution losses will be higher for electricity supply to rural areas than to urban areas. Eskom (personal communication: 1993) indicates a figure of 20% for distribution losses in rural areas, more than twice the figure applicable to urban areas.

The actual bulk supply cost charged by Eskom to distributors (either Eskom or others) is assumed to be 11.19 c/kWh (using a figure of 10.36 c/kWh in 1992 Rands, escalated by Eskom's average tariff increase of 8% for 1993). This figure includes capital and running costs of getting electricity to the boundary of the local distributor and covers all costs of generation, transmission and distribution up to this point of the electricity supply system (Eskom 1992). A capital replacement provision has to be added to the supply costs to account for future replacement of the local distribution system infrastructure of the distributor.

3.4.3 Cost of use – the tariff issue

Having discussed the cost of connection for new consumers as well as the supply and service costs, it is necessary to look at what it costs for the consumers to use electricity in rural areas. The cost of use is reflected in the tariff to be paid by the consumers.

A recent survey (Eskom 1992c) of household tariffs applied by various local electricity distributors in South Africa, revealed that more than 1 100 different tariffs

exist. Considerable diversity was found in connection fees, level of service, approaches to dealing with the costs of reticulation network and house connection, tariff structure and the energy charge.

All energy prices should, in principle, be based on the concept of efficient use of national resources as well as providing cost recovery for the utility charged with the task to provide the energy service. No comprehensive analyses have been carried out of economic efficient energy prices for South Africa. In lieu of this, and in order to promote greater equity in access to electricity for poor households in South Africa, but without at the same time severely endangering the financial viability of the electricity distribution industry, EPRET (Pickering 1993) is proposing to introduce a national flat (straight-line) tariff to be applied to all domestic consumers, independently of which local distributor is actually providing the supply. Such a tariff can easily be applied to all new electricity consumers, but will most likely have to be phased in over some time for existing domestic consumers, in parallel with a foreseen reorganisation of the electricity distribution industry in South Africa (Steyn 1993). A national flat tariff assumes that the electricity utility advances the cost of connection against a later repayment through the tariff charged for electricity use. The cost of supply and cost to consumer with the proposed national flat tariff is shown in Figure 3.2 below.

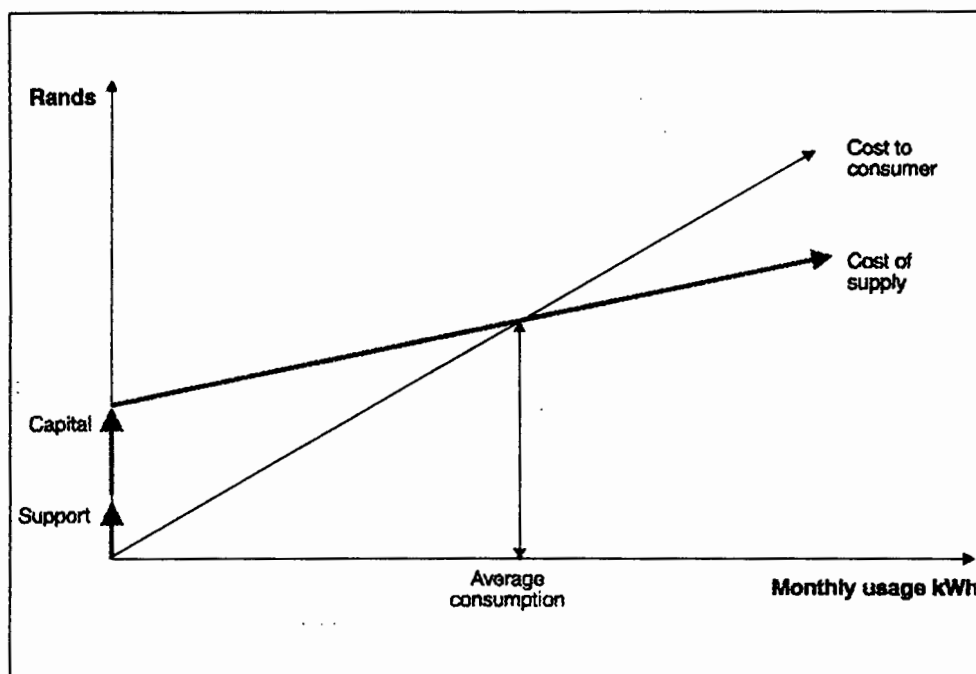


FIGURE 3.2 Cost of supply and cost to consumer with flat-rate tariff
 Source: Pickering (1993)

A level of 20 c/kWh (excl. VAT) is being proposed by EPRET for the new national domestic tariff. The proposed tariff is similar in construction to the present S-1 type of tariff being applied by Eskom for new consumers connected as part of their electrification programme, using pre-payment metering systems and ready boards as the base technology for house connection. The proposed tariff level is also in line with the actual tariff being charged by Eskom for their S1-tariff (20.35 c/kWh excl. VAT for 1993). The concept of a straight-line tariff implies that the customer pays the same amount for a kWh, regardless of the actual number of units consumed. No fixed monthly charge is to be applied. The basis for Eskom's S1-tariff level is a monthly consumption of 350 kWh. This is the break-even consumption level required to recover connection cost and variable supply costs. The proposed tariff structure and level imply that consumers using less than 350 kWh/month will be

subsidised by other domestic consumers using more than this amount of electricity on a monthly basis. The proposed tariff system will hence imply a redistribution of resources from (wealthy) urban to (poor) rural areas.

Most, even virtually all, rural consumers of electricity are expected to use less than 350 kWh per month. The average consumption level of 300 000 newly electrified Eskom customers, all on the S1-tariff, is about 80 kWh/month. Figures from Durban Electricity, based on sales to about 30 000 newly electrified consumers, indicate monthly consumption figures of 120-150 kWh. Durban Electricity has, however, provided its consumers with a two-plate hot-plate, paid through the connection fee, in order to stimulate use of electricity.

The low usage figures recorded by Eskom, Durban Electricity and other distributors apply mainly to urban poor households, but also to some rural households. There is no reason to believe that the consumption in rural 'homeland' areas should be higher than in urban areas. In fact, figures of about 50 kWh/month have been recorded for such customers. The only exception might be electrified farmworker houses, where the support for electricity provision from the farmer is considerable, and in regions where the average household income is fairly high (for example in south-west Cape). Hofmeyr (1993) found that consumption levels in such cases might be as high as 200 kWh/month. Even under such favourable conditions, the monthly revenue to the utility will only be about R45, barely enough to cover variable supply costs and the monthly fixed service cost, but no redemption of initial capital outlays to cover connection costs.

For the analysis of financial implications of a major rural electrification programme for South Africa, EPRET assumes an initial consumption of 60 kWh/month, increasing by 25% per year until it reaches a maximum level of 150 kWh/year. This is equivalent to a monthly tariff revenue per customer of R15-R35, considerably below cost recovery levels and with no contribution to capital redemption over time. On this basis, all opportunities to improve consumption levels and reduce utility service costs should be analysed in detail and stimulated where a potential is identified. Sensitivity on the above assumptions will be analysed in chapter 6.3 of this paper.

3.4.4 Availability and affordability of electrical appliances

Availability and affordability of electrical appliances are key factors determining the success of an electrification programme. Use of electricity for lighting and media purposes will hardly result in consumption levels in excess of 60 kWh/month. The perceived benefit of electricity to the consumer increases considerable with the ability to use electricity for other end-use purposes such as example refrigeration, ironing, cooking and water-heating.

Electrical appliances are virtually non-existent in most rural households in 'homeland' areas. Radios and TVs might be available in some households, but are generally run on batteries (dry cell and car batteries). Some of these appliances cannot be run on normal grid-supplied electricity, and conversion costs are too high to be immediately affordable to the consumers. Existing energy appliances are usually paraffin lamps and cookers and gas cookers. When a household has acquired such appliances, they will often continue to be used even if the dwelling becomes electrified. The household can usually not afford to buy a new electrical appliance if it already has an appliance using another kind of energy supply.

Low income levels and virtually no access to consumer credit facilities imply that it is very difficult for rural households to afford the purchase of the required electrical appliances. Farmworkers on commercial, electrified farms will in some cases have a possibility of obtaining a credit from the farmer in order to purchase smaller appliances, to be paid back over time by deduction in the monthly salary payment. Hence the availability of appliances to farmworkers might be somewhat

better than to rural households in 'homeland' areas. The affordability question will be further elaborated below.

3.4.5 Electricity and the household budget

The objective of integrated energy planning (IEP) is, inter alia, to satisfy energy end-use requirements of consumers in an efficient, sustainable and equitable manner. This means that the needs of consumers and the interest of energy supply sectors need to be balanced. In the case of rural consumers – institutions like schools and clinics, and, in particular, households – it is of particular importance to avoid top-down energy supply solutions and to keep in mind that equity is a target in its own right. Therefore it is important to find out what are the *preferences* of rural households and their *ability* and *willingness* to pay. The ability to pay depends on the level of cash incomes of rural households, and the prices they have to pay for energy commodities. Preference is determined by how households choose to spend their income on energy commodities. A matching of preferences and the ability to pay would imply what could be a feasible energy demand profile for rural households under the constraints set by their economic circumstances and the support which might come from other consumers (cross-subsidies) and from the government.

Willingness to pay

In South Africa the *willingness to pay* discussion is closely connected to the revolt of households in townships against local government structures perceived to have little or no legitimacy. In the following we shall, however, not touch upon this political willingness to pay aspect because the focus here is on rural electrification, where electricity supply has yet to reach any wide penetration, and where the intention of supply authorities is to use pre-payment meters. Thus the willingness-to-pay aspect is assumed to coincide with the ability to pay. Willingness-to-pay problems could, however, become a problem in certain 'homelands' and self-governing territories. The present electricity supply to rural areas there, although limited in extent, has been heavily subsidised. For example, the Venda Electricity Corporation has been supplying households at a tariff of 0.12 c/kWh. If EPRET's proposal for a new national straight-line tariff of 22.8 c/kWh (20 c/kWh plus 14% VAT) was to be adopted, it would mean a substantial increase (in Venda by about 90%) if taken in one step. The situation in some of the SGTs are even more dramatic than in Venda, with domestic tariffs being reported to be as low as 1 c/kWh in certain areas.

Energy preferences

When it comes to rural household energy preferences, both South African politicians and the electricity supply industry (ESI) have, during recent years, promoted quite forcefully the supply of grid electricity also to rural areas. Eskom and Durban Electricity, for example, have promoted 'electricity for all' programmes. Even if grid supply would not be a least-cost solution for all rural households, and even if the ability to pay is low, it is nevertheless important to point out that a shift in the energy preferences of rural households seems to have taken place after 1986, now favouring electricity as the preferred form of energy (Griffin et al 1992: 84-6). This change could possibly be a reflection of the dramatic and unprecedented change of political climate in South Africa in recent years, through which it has become possible also for rural people to openly voice political and economic ideas and demands previously unacceptable to the national government.

The data available on rural household energy preferences is scant. Eberhard (1987) in his energy consumption study of six selected rural villages in Ciskei, Transkei, Eastern Transvaal (Gazankulu) and in North Eastern Transvaal (Lebowa), found that, in five of the villages studied, wood, coal, and to some extent paraffin were preferred to electricity for cooking and heating. While none of the villagers had

access to electricity, only in one of them (Cottondale) was electricity the preferred fuel for cooking and heating – presumably because the villagers in Cottondale knew about electricity on account of a nearby electricity line. When it came to lighting, paraffin was the preferred fuel, while candles and electricity came out about even (Eberhard 1987: 56-58). When asked about perceived factors which might make the villages a better place to live, improved water supply was more highly rated in all villages than was electricity (Eberhard 1987: 83). To sum up, electricity was not at that time considered the overall rural development priority in these villages.

In a recent study of household energy use in a peripheral rural area (Gazankulu) in the Eastern Transvaal lowveld (Griffin et al 1992), it was found that the preferred energy source (first choice) for cooking, heating and lighting (except in a refugee settlement) was electricity. None of the areas studied, however, actually had reticulated electricity (Griffin et al 1992: 84-87). Although the studies of Eberhard and Griffin do not cover the same settlements, they might conceivably be seen as some representation of the unfolding of a time continuum, through which electricity has moved up to become the preferred fuel, at least in some rural areas.

These findings are also supported by an (ongoing) study carried out by Lithole (1993) on financing of rural electrification in Venda. In discussions with civic organisations in Venda it has become quite clear that:

the few houses with electricity have shown tremendous preference for electricity over other sources of energy. To support this argument is the fact that they have always shown preparedness to pay for electricity (through up-front connection fees), even when the service are not entirely satisfactory).

A rural electrification programme now could therefore be in line with rural household preferences. Politicians and Eskom might have picked up this 'wind of change' and reinforced it as they went along, equating electricity with equity. At this point, one should nevertheless not forget Eberhard's findings concerning other factors which were considered as important agents for improvement of life in rural areas, such as improved water supply, educational and health facilities. The statement 'any initiative which aims to deal with rural energy scarcities must be integrated with broader rural development needs', is probably as true today as when it was written (Eberhard 1987: 84).

Ability to pay

Eskom has assumed as a basis for its S1-S3 tariffs that average monthly electricity consumption would give a break-even figure of 350 kWh/month. In EPRET's calculations of the costs of a rural electrification programme, it has been assumed that the monthly rural household electricity consumption would rise from 60 to 150 kWh over a ten-year period. Initially (according to EPRET's assumptions), electricity would be used for lighting and media (radios in particular); gradually, lighter energy services like ironing and some cooking would be electricity-based. This would probably mean that the demand for paraffin, candles and batteries would come under increasing competition from electricity, while 'heavy cooking' and space-heating would continue to come from firewood and coal. Using the proposed EPRET national tariff at 22.8 c/kWh (20 c/kWh plus VAT) and the kWh assumptions mentioned above, this would imply a monthly expenditure on electricity of R13.68 per month, rising to R34.80 after ten years (EPRET). The latter electricity consumption levels would, however, require substantial cross-subsidisation from non-rural consumers, as well as direct government funding (cf. chapter 6).

Table 3.10 inspects a recent detailed rural households' energy consumption pattern from Gazankulu (in Griffin et al 1992: 80), which also includes batteries. In particular, it might be worthwhile to see how introduced electricity might be 'fitted in'.

Fuel	Settlement					
	Athol	O'boom	Rolle	Ref'g	Wel'nd	Xanthia
Paraffin	13.46	21.60	19.39	4.03	19.87	18.16
Candles	3.82	9.18	9.99	3.79	6.14	7.64
Coal	0.84	4.26	2.09	0.00	1.49	0.00
Gas	4.29	3.07	10.16	0.00	4.86	4.29
Batteries	18.25	14.19	18.04	9.06	22.76	20.32
Generators	0.00	0.91	0.09	0.00	4.95	1.94
Electricity	0.00	0.29	1.60	0.00	0.00	0.00
Wood	2.00	28.74	23.90	0.00	9.13	7.46
Total energy expenditure	42.66	82.24	85.26	16.88	69.20	59.81
Total expenditure	412.00	453.00	434.00	162.00	89.00	473.00
Per cent energy expenditure ²	10%	18%	20%	10%	14%	13%

Notes

1. Edited from similar table in Griffin 1992, covering the following settlements in the Mhala region of Gazankulu: Athol, Welverdiend (Wel'nd), Rolle, Xanthia, Okkerneutboom (O'boom) and one Mozambican war refugee settlement adjoining Welverdiend.
2. Griffin et al 1992: 91.

TABLE 3.10 Mean monthly household expenditure (in 1991 Rands), selected settlements

Source: Griffin et al (1992: 80)⁽¹⁾

The large expenditure on *batteries* should be noted. Electricity, if and when introduced, would most probably be used initially for end-uses like lighting, media and some cooking. Assuming that the stated expenditure on candles, paraffin and batteries, including electricity from generators and grid, could be considered a proxy for the latent demand for electricity, and using the proposed new national tariff (22.8 c/kWh incl. VAT), it could support an electricity consumption of between 155 kWh/month in Athol and 235 kWh/month in Xanthia. While being far short of the basis for Eskom's S1-S3 tariffs at 350 kWh/month, the calculated average household loads would all exceed the upper bound for EPRET's scenario assumption (150 kWh after ten years). One should, however, remember that the above calculation is a bit 'optimistic', assuming no use of candles, batteries and paraffin after introduction of electricity. For this to happen, the reliability of electricity supply would have to be high, the access to pre-payment tokens near perfect, and radios should be able to be connected to the mains etc. On the other hand, it is an indication that EPRET's assumption for the initial (1994) electricity consumption levels (cf. Chapter 6) are on the safe side.

Based on an income expenditure sampling survey from Ciskei (HSRC 1992: 6, 24-25, 29) monthly total energy consumption per rural household can be calculated at about R18, less than 4% of monthly cash expenditure. This we find low, but corresponding to similar findings by Hofmeyr (1993) for energy expenditure by rural farmworker households. Eberhard, in his study (1987: 56), found the average energy share of the budget to be at about 10%, while Griffin (1992) found it to be between 10% and 20%. The average monthly household income (R406) estimated in the HSRC study is, however, broadly in line with Griffin's study. The reason could be that the 'fuel and light' expenditure categories used in the HSRC study (electricity, coal, firewood, gas, oil, and other - candles) do not include batteries, which presumably are included under another expenditure category. In that case the energy expenses are not comparable, for example, to those of Griffin. We also find the average household consumption of candles (R1.69) low when compared

to both Griffin and Eberhard, while the average monthly household consumption of gas and oil (paraffin?) at R13.90 is about half of those reported in Griffin.

3.5 The scope for electrification – a brief summing-up

This chapter has discussed the scope for electrification in South Africa in both macro and micro contexts – the latter with particular reference to the situation in rural areas. The overall challenge is considerable. About 5.3 million poor households are presently without access to electricity, of which about 3 million reside in rural areas. Political pressure is mounting to electrify a major part of these households over a quite short period of time and in an equitable way. This will imply a massive electrification programme to be undertaken at the same time as an important reorganisation of the fragmented electricity distribution industry is being pursued. Furthermore, the electrification programme will face problems with increasing connection costs (particularly as the programme moves to rural areas), high customer service costs, low consumption levels and, consequently, insufficient tariff revenues to the electricity utilities.

To handle these challenges at the industry level, the following elements must be given detailed consideration:

- Establishment of a national straight-line household tariff.
- Establishment of a set of national connection cost parameters, which may differ between household categories based on objective criteria like distance from existing grid.
- Establishment of a national service cost parameter.
- Adherence to the principle of least-cost supply options, including use of RAPS solutions where such are found suitable.
- Preservation of a financially viable electricity supply and distribution industry.
- Creation of mechanisms where excess capital and operating expenditure can be covered through extra contributions (in kind or in cash) from the connectees, or by external subsidies – probably from the fiscus.

At the micro level – the level of the potential new electricity consumers – we have incomplete, but wide-ranging, information on household expenditures on energy commodities, both for urban areas (not the scope of this paper) and rural households on commercial farming land and in South African 'homelands'. The energy expenditures in rural areas are low. If access to electricity were to be introduced on a large scale, household demand for electricity would give low initial loads. It is therefore important that rural electrification is introduced in a manner which would look for other loads in addition to households': those of community institutions (schools, clinics, administrative offices etc) and of local businesses where, perhaps, an identifiable load would already be in place through the use of gensets. In addition, it would be crucial to plan carefully the siting of new government institutions to coincide with actual rural electrification, keeping in mind the need for a higher initial load. The need for cross-subsidies from non-household consumers would nevertheless be crucial.

Ongoing electrification in rural areas

4.1 Eskom's electrification programme

Eskom's size and position in the electricity supply industry makes the corporation the major player in the future electrification of households throughout the 'new' South Africa. The organisation already clearly recognises that rural electrification (RE) is going to be a major challenge in the years ahead. Hence, it is of great interest to look more closely into how Eskom plans its future electrification programme. This will first be done by looking at some features of the overall electrification programme and thereafter discussing more closely how one of Eskom's distributors approaches electrification within its supply area.

4.1.1 Approach, characteristics and overall targets

Eskom has been, and still is, characterised by a strong engineering approach to the tasks it is mandated to fulfil. The organisation's mission is stated as: to 'Provide the means by which customers' electricity needs are satisfied in the most cost-effective way subject to resource constraints and the national interest.' The major customer groups for Eskom have traditionally been the mining sector, industrial and commercial undertakings and a number of larger bulk consumers, typically represented by 'white' municipal electricity distribution undertakings. Eskom's strategy and planning have consequently been focused on generation, transmission and bulk supply. Since the mid 1980s, Eskom's focus has gradually started shifting towards meeting the electricity needs of the household sector. This shift was initiated by certain subsidised schemes to electrify 'white' commercial farmers throughout the country. Gradually (from about 1985) it also became necessary to pay more attention to electrification of major 'black' townships like Soweto and, later, also other township areas around the major metropolitan areas in South Africa.

Due to an increasing political pressure over time, Eskom has seen it necessary to intensify its marketing efforts aimed at 'bringing electricity, where appropriate and cost effective, to households and other consumers which are still using other energy sources' (Eskom 1992: 1). The organisation is now 'committed to making electricity available to all in South Africa who want it and can afford it' (ibid.). The result of the recent marketing thrust aimed at the household sector resulted in Eskom becoming the largest electricity retailer in South Africa in 1992, when it bypassed Durban Electricity. The number of direct Eskom consumers grew by about 95% in 1992, mainly due to the electrification of about 145 000 homes and the takeover of existing customers in other local distribution areas, particularly areas traditionally served by black local authorities (BLAs). Eskom's direct customer base at the end of 1992 consisted of about 542 000 customers, of which 397 000 were domestic urban consumers and another 122 000 rural households and farms. The remainder were commercial, industrial, mining and other large consumers.

The political pressure on Eskom to accelerate its electrification effort and continue to take over supply rights from other financially troubled local authorities (particularly BLAs in homeland areas in SGTs and TBVCs) is all the time increasing. Eskom estimates to have access, by the end of 1993, to about 50% of all non-electrified areas, but admits that it will be hard to follow up all the new responsibilities assigned to the organisation.

Eskom recognises that the corporation has not been close enough to its domestic consumer market and hence that basic customer information necessary to plan future electrification programmes in sufficient detail has been lacking. Despite this, Eskom embarked on its household electrification programme in 1987 when 5 000

new households were connected. By 1993, this annual connection rate had increased to about 170 000 households. Over the last three years, a total of 300 000 new domestic consumers have been connected by Eskom, most of these in urban township areas and on new low-cost housing developments undertaken on a site-and-service basis. Certain parts of Eskom's organisation (Eskom 1993: personal communication) feel that 'the present speed of connection is on the brink of what the organisation possibly can handle'. A major and growing problem is to maintain and keep a sufficient level of customer service for the rapidly expanding domestic customer base. Customer service operations are also hampered by present political problems in many areas which limit access for Eskom staff to carry out necessary maintenance, repair and customer service operations.

For the seven-year period 1992-98 Eskom has committed itself to carry out 912 000 new connections. The present electrification programme takes this even a step further by increasing the programme target to 938 000 connections by the end of 1998. The programme design is based on the actual and foreseen supply situation for the various areas of the country, analysing both financial, construction and customer services needs as part of the planning process. Eskom considers an annual target of 150 000 to 200 000 new Eskom connections per year to be possible. Increasing the targets above this level would put considerable pressures on the organisation's financial, planning and manpower resources. The electrification programme is built around Eskom's five regional distributors in Bloemfontein, Cape Town, Durban, Johannesburg and Pretoria, with close cooperation taking place between the distributors and Eskom's head office in Megawatt Park.

Each of the Eskom distributors is responsible for electrification of rural areas and homeland areas within its geographical boundaries. In principle, the responsibility is limited to 'homeland' areas where Eskom presently have supply rights, but, in practice, planning is already carried out for adjacent areas where Eskom has been asked to take over supply rights, or where in the future Eskom will, most likely, be responsible for electricity distribution. Table 4.1 below gives an overview of how the various 'homeland' areas relate to Eskom's five regional distributors. From the table it is obvious that most of the responsibility for RE lies with Eskom's Pretoria distributor.

<i>Eskom distributor</i>	<i>Related 'homeland' areas</i>
Bloemfontein	Part of Bophuthatswana; Qwaqwa
Cape Town	Transkei; Ciskei
Durban	KwaZulu
Johannesburg	—
Pretoria	Part of Bop'tswana; Venda; Lebowa; Gazankulu; Kwandabele; Kangwane

TABLE 4.1 Eskom's regional distributors and the 'homeland' areas
Source: Eskom's national electrification planning division (1993)

Tables 4.2 to 4.4 below describe certain features of Eskom's national electrification programme – how it is distributed geographically between the various distributors and what kind of households are targeted by the programme. It must be pointed out that such a major electrification programme must be dynamic and will continually be updated, as better data becomes available and experience is gained and fed back to the organisation. Hence, the later parts of the electrification programme will quite certainly be adjusted considerably in the time to come.

Distributor	1992	1993	1994	1995	1996	1997	1998
Bloemfontein	18 000	30 000	32 000	28 000	21 000	12 000	6 000
Cape Town	12 000	15 000	15 000	15 000	15 000	6 000	2 000
Durban	25 000	35 000	35 000	30 500	38 000	30 000	18 000
Johannesburg	32 000	42 000	50 000	50 000	30 000	15 000	6 000
Pretoria	34 000	36 000	36 000	40 000	45 000	40 000	18 000
Total per year	121 000	158 000	168 000	163 500	149 000	103 000	50 000
Cumulative tot.	121 000	279 000	447 000	610 500	759 500	862 500	912 500

TABLE 4.2 Eskom's electrification programme – customers connected by distributor

Source: Eskom's national electrification planning division (1993)

Table 4.2 shows that Eskom's planned programme reaches a ceiling of about 170 000 new connections in 1994. This is about the same number of connections as was made in 1993. This activity level will be retained also for 1995 and 1996, while the programme thereafter will be reduced to much lower levels. The table also shows that most new connections (about 27%) will be made by the Pretoria distributor, which is the region where most of the 'homeland' areas are. The Cape Town distributor, on the other hand, will only be responsible for about 9% of the electrification programme. The Johannesburg distributor will be responsible for 25% of the connections, almost all of these in urban townships and site-and-service areas. The distribution by household types is further elaborated in Table 4.3.

Category	1993	1994	1995	1996	1997	1998	SUM
Township etc.	101 000	115 500	100 500	73 000	37 000	18 500	445 500
Rural village	39 000	40 700	50 000	52 500	48 500	24 000	254 700
Rural	14 000	8 500	10 000	19 500	14 000	6 000	72 000
Farm lab'ers	4 000	3 300	3 000	4 000	3 500	1 500	19 300
Total per year	158 000	168 000	163 500	149 000	103 000	50 000	791 500
Cumulative tot	158 000	326 000	489 500	638 500	741 500	791 500	

TABLE 4.3 Eskom's 1993-98 electrification programme by customer category

Source: Eskom's national electrification planning division (1993)

Table 4.3 shows that the early part of Eskom's electrification programme focuses primarily on electrification of urban townships and site-and-service areas. Rural villages get considerable attention throughout the programme, while the focus on more remote and scattered rural areas generally is much lower.

Most surprising is, however, the small focus on electrification of farmworker households, particularly taking into account the large number of households involved and the rather low expected cost per connection. The meagre attention paid to electrification of farmworker houses might reflect the fact that these households do not have any efficient political channels to express and argue their needs, but also the fact that electrification of worker households traditionally has been viewed (also by Eskom) as a responsibility of the farmer alone. Some recent communication with Eskom indicates that farmworker electrification is in the process of being given more attention, with recent connection rates being in the range of more than 1 000 dwellings per month. It is, however, the opinion of the authors that electrification of worker houses should be given much more attention as part of a major RE programme. Such an approach is also strongly supported by Hofmeyr (1993) in her study of farmworker households, as discussed in chapters 3.3.1 and 3.4.1 of this paper, and is supported in the proposed EPRET RE pro-

gramme (see Chapter 6.2).

Considerable regional differences are observed with regard to how the different Eskom distributors prioritise their electrification efforts with regard to the various household categories. A summary of the planning targets for the programme period 1992 to 1998 is presented in Table 4.4 below.

Category	Bloemf'n	C Town	Durban	Joh'burg	Pretoria	Total
Township/site-and-service	68%	66%	36%	96%	24%	55%
Rural village	19%	19%	51%	1%	54%	32%
Rural	9%	8%	11%	2%	20%	11%
Farm labourers	4%	11%	2%	1%	2%	2%
Total	100%	100%	100%	100%	100%	

TABLE 4.4 Electrification by distributor and household category
- percentage figures 1992-98

Source: Eskom's national electrification planning division

Table 4.4 shows that the Bloemfontein and Cape Town distributors mainly give priority to urban electrification, although also with some focus on what are called rural villages. The Durban distributor, and even more the Pretoria one, do, on the other hand, give particular attention to rural villages. This obviously has to do with the fact that these two distributors also are responsible for supply of most of the densely populated 'homeland' areas, in Durban's case a considerable number of rural KwaZulu towns, and in the case of Pretoria most of the other former SGTs plus Venda and part of Bophuthatswana. The Johannesburg distributor has the responsibility for a large metropolitan area and, as such, is mostly occupied with electrification of poorer households in dense urban areas.

It total, it appears that Eskom plans to give considerable attention to rural areas, with 32% and 11% respectively of the entire electrification programme being aimed at rural villages and rural households. The rural focus gradually increases over the 1992 to 1998 programme period. Again, it is necessary to point out that the classifications might be misleading - particularly the understanding of 'rural village' might be ambiguous. Often one observes that the term 'rural' merely reflects a household with very low income levels, quite independently of where the household actually is located. The true rural component of the programme for 1993 is probably about 10% of the total number of new connections.

Eskom's national electrification planning process is built on developing scenarios for the number of connections to be made, geographical location and household categories to be targeted. Thereafter the scenario is subjected to comprehensive financial analysis, followed by risk analysis in order to give input to actual work programmes, sales strategies and marketing efforts in areas to be targeted for electrification.

The analyses include determination of sales profiles (kWh sold per customer per annum), sales by distributors, expected capital cost per connection (with breakdown by customer category) and capital investment required per distributor. The effect of the planned electrification programme on Eskom's financial performance are calculated by use of financial input parameters like discount rate, inflation rate and future tariff increase, technical input parameters like line losses, load factor and load diversity factor, together with the projected marginal cost of transmission and generation to meet the future loads resulting from the electrification programme.

4.1.2 The case of Eskom's Natal distributor

In order to illustrate better how RE is being planned and carried out, the authors carried out some fieldwork in Natal. This included discussions with Eskom's Natal distributor based in Durban, as well as visits to selected newly electrified areas and areas in the process of being electrified.

Organisation of electrification planning at distributor level

Eskom's Durban distributor responsible for the Natal area has appointed an electrification manager with special responsibility for planning and following up the electrification of domestic consumers in the Natal region. The electrification manager is charged with the responsibility of leading a small Coordinating Division which, in addition to the manager, also includes a planner and a small enterprise development specialist. This coordinating division operates in a matrix organisation interacting with normal line divisions responsible for marketing, sales and customer service, engineering, construction and maintenance. A main objective of establishing the new organisational unit was to increase Eskom's interaction with stakeholder representatives at a local level.

Business planning targets and recent adjustments

The Natal distributor operates with standardised five-year business plans, common to the entire Eskom system. These plans are updated annually and rolled forward, a process with several iterations with the overall national electrification planning division at Eskom's head office. The identification of prospective customers is, however, the responsibility of the local distributor – a sound principle recognising that the ones closest to the reality should be the first to provide input.

The Natal distributor carried out a total of 16 000 connections in 1991, a number which increased considerably in 1992 to reach a total of 42 000 new Eskom consumers. Approximately 10% of these were consumers taken over from other distribution authorities as part of the national development of transferring supply rights from local 'homeland' administrations to Eskom. Eskom in Natal has so far taken over the responsibility of supplying five rural KwaZulu towns, but more take-overs from the KwaZulu administration (Department of Works) are being negotiated because of payment problems and poor administration of the BLAs responsible for KwaZulu electrification.

It is becoming increasingly clear to the Natal distributor that such take-overs should be carried out in a step-wise approach and to the mutual benefit to both the 'new' and the 'old' distributor. In order for take-overs not to be too much of a burden on Eskom-Natal, priority has been given to taking over supply rights in urban areas ('rural towns') where monthly sales figures are fairly high and service costs at an acceptable level. Take-overs of supply rights in KwaZulu are in most cases based on a leasing arrangement, where the local administration has a right to regain the supply rights at a future point. As part of the take-over agreement, Eskom usually has to agree to an interim flat fixed tariff for existing consumers until they can be reconnected with pre-payment meters and ready boards in order to be put on Eskom's normal S-type of tariff. Eskom's experience in Natal is that consumption levels increase rapidly in this interim period due to the fixed monthly payment arrangement. Hence, Eskom is trying to limit the transition time as much as possible in order to reduce financial losses. This process of an interim tariff and resulting financial losses is a further argument as to why Eskom take-over of supply rights has to be done through a step-wise approach. The result is, however, that *the required restructuring of the South African electricity distribution industry, also in 'homeland' areas, will take considerable time to complete.* Eskom take-over of supply rights in Natal is not limited to KwaZulu, but includes former trust areas now being administered by the Natal Provincial Administration.

Having experienced an 'explosion' in new connections from 1991 to 1992, the

number of new consumers in 1993 is expected to stabilise at the same level as in 1992, at about 46 000 new connections and another 3 200 customers being taken over from other distributors. The budget target for 1994 was in the same range – 48 000 new connections – but has recently been scaled down to 38 000 due to experiences with *slow or even negative sales development* (in cases where supply rights have been taken over by Eskom) and *high and increasing connection costs*. Although Eskom in Natal agrees that the corporation will have to take on some business risks in order to meet its electrification targets, the level of risk should be evaluated continuously and be up for discussion. Average sales to newly electrified consumers in Natal is about 80 kWh/month, but with a considerable spread from 35 to 1 000 kWh/month. The latter figure most likely refers to non-domestic users who for some reason have been given a domestic tariff. Urban townships recently being taken over by Eskom shows monthly consumption levels in the range of 500 to 600 kWh. These figures are very high, but are seen to reflect the low fixed tariff agreed as part of the take-over. Average connection costs for electrification of new consumers in Natal are presently about R3 300 per connection, but with figures as high as R5 400 in rural areas. Although connection costs might be high in rural areas, it is not possible to leave these areas out altogether due to former political promises and for reasons of proving commitment and legitimacy to the national electrification programme. A point in question in this connection, however, might be how costs of shared facilities (for example reinforcement of the general high- and medium-voltage distribution system) are allocated to new consumers. The recorded connection costs for consumers being electrified at this time might be too high, as a portion of the costs also will benefit consumers to be electrified some years ahead.

Another problem being given increasing attention presently is *marketing of appliances* to support the electrification programme. Eskom estimates that the potential sales increase due to marketing efforts could be in the range of 20% for newly electrified consumers.

Eskom-Natal is focusing strongly on introducing increased efficiency in the organisation (by use of benchmarking), with particular focus on customer services. This is necessary as Eskom is presently reducing staff numbers at the same time as the electrification drive requires more of the organisation's resources. In addition, Eskom is pursuing changes in staff mix as part of affirmative action programmes.

Preferred approach to RE

Eskom realises that not all households want electricity supply, either because they are not familiar with the product, or other energy commodities are preferred to electricity. The implication is that there is a need for looking at integrated rural energy usage, in all areas, in cooperation between Eskom and other involved parties (for example oil companies, Department of Forestry, Department of Mineral and Energy Affairs (DMEA)). In those rural areas where electricity is a preferred supply option, Eskom's electrification planning pays increasing attention to identifying socio-economic factors that might indicate that an area is a prospective rural centre with a clear potential for economic growth.

RE by Eskom in Natal is increasingly being *focused on electrification of growth centres*, as the preferred approach. In practice this implies that extension of the grid will be done with priority given to connection of new rural centres, with particular focus on the electrification of community facilities and small-scale productive enterprises that can provide the basis for economic activity and growth in the area. This approach ensures that a certain initial load and, hence, sales revenue exist from the start of the electrification programme. Potential consumers in the areas between the existing termination point of the grid and the new electrified centre will only be connected later, when the main distribution infrastructure already is in place. On the other hand, when electrification of households starts in a rural area, Eskom's

policy is to electrify virtually all households in the area, whether they have indicated that they want to be connected or not. This approach is chosen because return to the same areas later to execute 'fill-in' connections is rather costly. The power is, however, only switched on when the consumer has paid the symbolic connection fee of R35.

Eskom recognises that focusing on electrification of growth centres might imply an equity problem with regard to providing equal opportunity to all households with regard to access to electricity. Equity considerations will, however, have to be balanced against broader development objectives in rural areas. In order to alleviate the perceived equity problem, Eskom is paying particular attention to liaison with stakeholders involved in RE. This is discussed further in the next section.

Stakeholder involvement

In order to ensure stakeholder involvement in the electrification programme in Natal, Eskom has proposed the establishment of an *electricity sub-committee* under the Regional Economic Forum, to discuss priorities for electrification with CBOs and NGOs working in Natal. The main aim is to discuss criteria for prioritisation of electrification projects, particularly how to handle the distinction between a RE programme based on equity or development considerations. Prior to meeting with the electricity sub-committee, Eskom local management and representatives of trade unions organising Eskom employees will meet in order to establish a joint position on the electrification programme. Stakeholder involvement is seen as a process of community empowerment and will provide input to Eskom's business planning process, including costing and analysis of service levels. It can also contribute to the creation of joint funding arrangements where local funds are matched with Eskom resources in order to reduce the connection and service costs to acceptable levels. Creation of an electricity sub-committee is also seen as a means of linking electrification to a broader programme for reconstruction and development of rural areas. Stakeholder involvement shall advise, *not* control the electrification programme. The important point is for Eskom to take account of non-political initiatives rooted locally on a sound development basis, and be open to allowing such input to impact significantly on future programmes.

Members to be elected to the electricity sub-committee would be drawn from the regional economic forum and would typically be representatives for key political parties, national trade unions, civics, business organisations, community based organisations (CBOs) and NGOs (particularly those involved in rural areas).

Cooperation with Durban Electricity

Both Eskom-Natal and Durban Electricity operate in rural areas of Natal, often quite close to each other. This is due to the fact that both distributors have taken over supply rights in certain areas of KwaZulu, particularly for supply of rural towns.

In order to coordinate the electrification activities in the best possible way, a number of institutional and organisational arrangements have been established. These include:

- Standard Marketing Forum.
- Customer Executive Forum (standard Eskom set-up to liaise with all its major customer, including bulk customers like Durban Electricity).
- Incentive scheme provided to Durban Electricity for electrification purposes (in the form of a discount on energy tariffs for bulk purchases, possibly to be changed to a cash support per new customer electrified).
- Preparation of joint sales forecasts as an input to the electrification planning process.

- Development of joint communication systems and a joint fault centre (under implementation).
- Establishing procedures for resolving boundary disputes (in areas where supply rights are questionable).

In addition, the two organisations are also discussing the possible establishment of a Standing Liaison Committee at executive level to further improve coordination of electrification programmes and system operations.

Approaches to non-grid electrification

It is recognised that certain areas will not be electrified by standard grid-extension, due to very remote locations and limited load potential. To cope with these areas, Eskom-Natal has engaged in interaction with both Eskom's central research division (TRI) as well as with EDG (Energy for Development Group) and the DMEA.

Discussions with Eskom's own technology group have concluded that only *PV-systems* might be an alternative to grid-electricity in Natal. As a consequence, Eskom-Natal has allocated R3 million for development of remote area power supply (RAPS) supply in certain areas. The domestic tariff foreseen by Eskom for such a supply option will be R65/month, but the supply will only be sufficient for lighting and media purposes. Eskom realises that 'RAPS very well could be handled by private sector organisations or other parties, but feels that Eskom's name will give the RAPS systems a certain credibility in rural areas.' The criteria Eskom-Natal intends to apply for use of RAPS systems in a rural area will be that the area shall not be included in Eskom's five year business plan for grid-supply and that it is located more than 5km away from the grid.

Interactions with EDG and DMEA have focused on development of design manuals, costing procedures and analysis of potential suppliers. The general feeling is that the technology side is by now fairly well developed, while considerable uncertainties relate to the revenue side and institutional arrangements for implementation of RAPS solutions as part of Eskom supply. Particularly the issue of first line maintenance appears problematic.

A number of discussions have also been held with the Department of Health and Education in the KwaZulu administration regarding use of communal PV-systems, with payment to the utility based on avoided electricity costs.

4.2 Electrification by major municipal electricity distributors

4.2.1 General

When discussing electrification of rural areas, the main industry participants are Eskom and the remaining 'homeland' distribution authorities. However, a number of major (white) municipal electricity distributors also engage in electrification of rural areas in the outskirts of their supply areas. The major municipal distribution authorities with comprehensive household electrification programmes are Bloemfontein, Durban and Port Elizabeth. In 1992 these authorities connected more than 50 000 new households. It is, however, not clear how much of this was in rural areas. Some municipal electricity departments have also been involved in take-over of supply rights in homeland areas, for example in KwaZulu where Durban Electricity has taken over the supply of several rural KwaZulu towns and surrounding areas. The experiences, plans and approaches applied by Durban Electricity is discussed further in the next section.

4.2.2 The case of Durban Electricity

Durban Electricity (DE) is the second largest distributor in South Africa with a total staff of about 3 200 and a domestic consumer base of 260 000 households. This includes the original low-density residential areas, townships south and north of Durban, and rural areas in the perimeter of the supply area. The original supply area covers about 1 600 km² within a 45km radius from Durban. As such, the supply area is much larger than the borders of the municipality of Durban. During the last four to five years, the area has also been extended further by the take-over of supply rights in certain areas of KwaZulu. The supply area is divided into three regions (North, Central and South). Each region runs two depots for local customer service operations. In addition, DE has central administration at head office and a large central workshop complex providing a multitude of repair and maintenance services.

DE is experiencing considerable problems with bad debt. It is believed that this is mainly due to use of traditional credit meters in township areas. Payment boycotts etc have resulted in a large number of disconnections and many instances where the customers have been found to have bypassed the meter. For electrification of new domestic customers, DE is now pursuing the use of pre-payment metering systems.

During fieldwork in Natal, the authors had discussions with staff of DE and visited certain rural areas where electrification programmes were ongoing. Areas visited were located in the Valley of a Thousand Hills, a dense rural area served by DE's Central supply region, about 50 to 60 km inland from Durban, but with difficult topographical conditions for electrification.

The 'Electricity for all' programme

In September 1991 Durban Electricity (DE) initiated what they call the 'Electricity for all' (EFA) programme. The *target* for the programme, running over a five-year period, is to connect about 168 000 dwellings, a number that might increase over the programme period due to increasing number of households in the project areas. Support for the programme is received through Eskom's incentive schemes in the form of discount on bulk purchases.

Up to the middle of August 1993, about two years after the start of the programme, 30 000 new customers had been connected. The present connection rate is 2 500 new connections per month, a rate which is expected to increase to about 3 000. Capital expenditure on the EFA programme is expected to reach R118 million for the financial year 1993/94, about 42% of the total capital investment budget for this year. For comparison it can be mentioned that the total expected sales revenue for DE for the 1993/94 financial year is R1.1 billion, with only about R12 million coming from the 30 000 newly electrified consumers.

The connection fee for new customers connected under the EFA programme is R142.50, a fee which, in addition to the pre-payment meter and the ready board, also includes a two-plate hot-plate in order to stimulate electricity use for purposes other than lighting and media only. This is about R100 more than Eskom's connection fee, but merely reflects the value of the two-plate hot plate included by DE as part of the connection. Before the start of the EFA programme, the connection fee was R600 for domestic connections.

Average consumption level for the 30 000 newly electrified consumers under the EFA programme is in the range of 140-150 kWh/month, somewhat higher than figures experienced by Eskom in similar areas of Natal. This might be due to the fact that DE provides the customers with access to a thermal appliance as part of their connection. When visiting the Valley of a Thousand Hills, the authors personally observed that the hot-plate was in use for cooking purposes in several of the newly electrified households.

The domestic tariff charged by DE is an S-type of tariff with the unit energy charge being 22.65 c/kWh (very similar to Eskom's S1-tariff of 23.20 c/kWh). This tariff is about 3 c/kWh higher than the normal domestic tariff charged by DE for metered domestic supply. The tariff is calculated on the basis of a break-even consumption level of 300 kWh/month and the capital costs are supposed to be recovered over 20 years. This is slightly more favourable terms than used when calculating Eskom's S1-tariff. As the tariff is very similar to Eskom's, this could indicate that the capital cost of connection by DE is higher than the comparative Eskom connection cost.

The cost of connection experienced by DE in areas like the Valley of a Thousand Hills is about R6,500 per connection, including the investment in the main distribution system for the area. The cost excluding mains connection was stated to be R1 800 per connection. Private contractors are used extensively for the EFA programme with some 1 500 persons being involved presently.

In planning the electrification programme in the Valley of a Thousand Hills, DE has paid considerable attention to involving local tribal authorities and community councils in the detailed planning and implementation of the electrification projects. This local involvement includes use of local labour for construction purposes. The electrification of the area has also profited from other rural infrastructure developments taking place in the areas under the auspices of the Valley Trust.

In this connection it must be mentioned that street lighting has been included as part of the electrification project in the Valley of a Thousand Hills, because it was regarded as a priority by the local council. Another effect is, of course, to contribute to better load management for the electricity utility. Hence, introduction of street lighting is seen to benefit both the local consumers and the utility.

Sale of pre-payment tokens are presently only done from 10-15 vending points in major rural centres. The limited number of vending points is not considered a limitation on consumption levels presently. DE is, however, planning for the introduction of local vending points for pre-payment tokens at a limited number of selected local shops and post offices.

4.3 Electrification in 'homeland' areas

4.3.1 General

Information on ongoing electrification in 'homeland' areas is not easily available. Several reasons can be found for this, of which the two major ones might be: general fragmentation of the electricity distribution industry, and poor management and lack of financial reporting from 'homeland' distribution authorities. Furthermore, Eskom is presently engaged in negotiations about take over of supply rights in several 'homeland' areas, with a number of interim arrangement being in place. Some exceptions can be found from the above general situation, of which Bophuthatswana and Venda should be mentioned. Both prepare detailed annual reports with pertinent information about their operations and electrification programmes.

4.3.2 *The case of Bophuthatswana*

In Bophuthatswana, a 'homeland' with a very difficult geographical spatial lay-out (six different non-adjacent areas spread over a large territory), electricity distribution is undertaken by Bophuthatswana Electricity Corporation (Becor). After take-over of supply rights from Mmabatho City Council from 1 January 1992, Becor's licensed areas now covers the whole of Bophuthatswana, with the exception of the limited area contained within the municipal boundaries of Thaba'Nchu (Becor Annual Report 1992: 2). In this respect, the reorganisation of supply licence areas

taking place in Bophuthatswana can be seen as an example of how the overall restructuring of the electricity distribution industry will have to be done in order to improve the industry structure. Becor is, however, still faced with the problem that its distribution system consists of several separately dispersed networks, with Eskom's system crossing inbetween Becor's own system.

Becor is a rather large utility with about 54 300 customers, annual sales in the range of 3 135 GWh and a peak load of 567 MVA (all figures relate to the financial year ending 31 March 1992). This makes Becor one of Eskom's largest bulk customers. It must be mentioned that a major part of the load is related to the large Impala Platinum Mines. Compared with Botswana, a neighbouring country with only a slightly lower population than Bophuthatswana (1.4 versus 1.9 million people) and a similar economic structure, the number of consumers there are about 25 500, total sales are 940 GWh and the peak load is about 200MW.

In the 1992 financial year, Becor purchased electricity from Eskom at about 8 c/kWh, while the average price obtained per unit sold was about 10.4 c/kWh. Figures for 1993 appears quite similar, with the average purchase price being about 8.8 c/kWh and the average sales price about 10.9 c/kWh.

Becor is in a financially strong position and made a net profit after financial charges of R11.7 million in 1992. The annual turnover was R329.0 million. Becor has a very strong balance sheet with a debt equity ratio of 0.50. Accumulated capital reserves were at R142.5 million (of which R82.5 million is in a capital development fund) and total assets of R214.4 million. Funding of investments is done through net cash flow from operations, connection fees received and loans raised from financial institutions. Most of the loan financing is arranged through the Development Bank of Southern Africa (DBSA), with total loans outstanding of about R71 million by end of March 1992. Loans from DBSA carry interest rates of between 11% and 15%, have maturities of between 9 and 20 years and are guaranteed by the Bophuthatswana Government.

The number of consumers increased by about 12 000 in 1992, of which 6 800 were consumers taken over from the Mmabatho City Council, while a total of 5 200 new connections were made, the highest number of new connections achieved any year so far.

Becor is committed to continue its electrification efforts, but within the financial and operational limitations that exist.

The Corporation is acutely aware that there are many people in our rural areas who do not yet have electricity and it will continue to strive to do everything possible to extend its networks into these areas. It must, however, be appreciated that electricity can only be provided on a viable basis and to communities who are willing and able to pay for it' (Becor 1992: 3)

Several different domestic tariffs are in effect in Bophuthatswana, mainly because of the use of different metering technologies. For normally metered small consumers (with maximum demand of not more than 25kVA) the tariff as effective from 1 January 1993 is a service charge of R10.48 per month plus an energy charge of 14.41 c/kWh. Some domestic consumers have load limited supply (breaker tariff). These pay a fixed monthly service charge of R10.48 plus a fixed circuit-breaker charge varying between R14.41 per month for a 5A supply to R41.94 for a 15A supply (all tariffs quoted exclusive of VAT).

In recent years Becor has started using electricity dispensers for domestic consumers. Consumers who themselves cover the costs of low-voltage reticulation and house connection pay a flat energy charge of 15.02 c/kWh. This is quite similar to Eskom's S3-tariff of 15.26 c/kWh (excl. VAT). Alternatively, consumers with an electricity dispenser (pre-payment meter) can pay a flat tariff of 20.35 c/kWh and

a low connection fee (the exact size of the fee is not known, but is assumed to be similar to Eskom's R35 per connection). This tariff is limited to connections costing no more than R3 000. For more expensive connections, the customer will have to cover the costs in excess of R3 000. The tariff for customers with a low connection fee is exactly the same as Eskom's S1-tariff. However, Eskom has not stated explicitly that a maximum connection cost parameter of R3 000 applies to their S1-tariff.

Tariffs in Mmabatho are slightly different for metered domestic consumers. They are on an inclining block tariff (applied to both a fixed monthly charge and the energy charge). For monthly consumption levels up to 700 kWh, the fixed charge is R10.01 per month and the energy charge is 11.79 c/kWh.

4.3.3 The case of Venda

Another example of a rather well organised 'homeland' electricity distributor is Venda Electricity Corporation (VEC) or, as it is now officially called, Venda National Development Corporation Electricity Division (VND CED).

Venda has a population of about 580 000 in about 90 000 households (based on DBSA's assumption of about 6.4 persons per household in Venda), with an estimated 1993 population density of about 85 persons per km². The standard of living in Venda resembles that of typical rural areas, but the settlement patterns, with many quite large villages of about 2 500 households each, indicate that the 'homeland' has a more functionally urban or peri-urban character. A considerable part of the population hence lives in what EPRET has defined as dense rural settlements.

Venda started operating its own electricity distribution utility (VEC) in April 1987, based on funds made available from the Venda government, the Industrial Development Corporation and DBSA. At that time, there were about 3 000 electricity consumers in the 'homeland' area of Venda. About 14 000 households had access to electricity by the middle of 1993 – that is, about 15% of the population. Electrification of urban dwellings in the three most populated towns – Thohoyandou, Makwarela/Sibasa and Shayandima – is widespread with about 90% of the households in these areas having access to electricity.

Table 4.5 presents a picture of the development of electricity supply in Venda with some key features related to economic performance, sales and customer development, etc.

	<i>Financial year ending 31 March</i>			
	1990	1991	1992	1993
Sales incl. gov. subsidy (R '000)	15 319	19 792	26 271	29 393
Less purchases of energy (R '000)	7 408	9 687	12 920	14 383
Gross profit (R '000)	7 912	10 105	13 352	15 006
Less expenditure (R '000)	5 729	8 099	11 573	12 661
Operational profit (R '000)	2 183	2 006	1 779	2 345
Electricity purchases (MWh)	95.40	112.79	133.48	137.81
Electricity sales (MWh)	86.46	100.16	125.74	126.93
- large power users	55.03	62.21	72.99	67.46
- small power users	10.00	11.76	15.91	16.04
- domestic users	20.08	24.65	35.27	41.82
- others (street lighting etc)	1.35	1.54	1.57	1.61
Total no. of customers	6 528	8 532	11 126	15 013
- domestic customers	5 453	7 298	9 579	13 270
Average sales price obtained (c/kWh)	17.84	19.50	21.87	23.15

TABLE 4.5 Development of electricity supply in Venda 1990-93
Source: VND C – Electricity division, Management Report of 10 July 1993

Some comments are necessary with regard to Table 4.5. As can be seen, load growth is lately entirely related to growth in domestic consumption, which in the 1993 financial year amounted to about 33% of total sales. Domestic consumers account for about 89% of the total number of consumers. Of the sales to domestic customers it is estimated that about 45% went to consumers in urban areas (accounting for about 30% of the number of domestic consumers), while 55% were to rural consumers (about 70% of the domestic customer base). The growth in the sales to domestic customers is gradually worsening the load profile of the electricity utility, with the result that the overall system operation cost will increase. Growth in energy sales from 1992 to 1993 was about 6%, while peak demand increased by 11% (reaching a maximum system demand of 27.2 MVA). Distribution losses (technical losses) in Venda in 1992/93 were 11%, comparable to the average of technical losses for the last four years.

No information is available about non-technical losses. This would have been of considerable interest as Venda Electricity Corporation uses conventional credit meters and not pre-payment metering systems for their domestic consumers.

The average cost paid by Venda for purchases from Eskom in the financial year 1992/93 was 10.4 c/kWh (excl. VAT), with the cost in June 1993 being 11.2 c/kWh. The Eskom purchase cost includes a discount of 5.5 c/kWh granted by Eskom (part of their incentive scheme towards other distributors) on bulk purchases to supply newly electrified domestic customers. The purchase price should be compared to the average sales price obtained of 23.15 c/kWh. However, the latter figure includes a subsidy of R6.29 million given to the Venda Electricity Corporation by the government of Venda in support of domestic electricity consumers. Excluding this subsidy, the average price obtained on sales would be 18.2 c/kWh.

Domestic tariff, Government subsidy and average consumption levels

The tariff charged to domestic customers in 1993 was 11.15 c/kWh plus a fixed monthly charge of R13.29 (figures excluding VAT). This is charged after a 50% government subsidy of the domestic tariffs. This subsidy was introduced in April 1990. Accumulated government contributions to Venda Electricity Corporation over a three-year period up to end of March 1993 amounted to R13.85 million (in current prices), with the subsidy in 1992/93 amounting to R6.29 million, as mentioned above.

Average monthly consumption levels for domestic consumer groups in Venda is presented in Table 4.6 below, together with the average price paid per kWh (calculated as energy charge plus fixed charge divided by recorded sales of electricity for each group). The three first consumer groups are in urban areas, while the fourth is predominantly households located in dense rural settlements. The average consumption level for all domestic consumers in the twelve-month period June 1992 to May 1993 was 263 kWh/month and the average price paid 15.59 c/kWh. It is estimated that newly connected customers outside the urban centres will typically use 180 kWh/month, gradually increasing to about 263 kWh/month after five years.

Consumer group	No. of consumers	Monthly consumption per consumer	Average price paid
Thohoyandou	1 548	571 kWh	13.89 c/kWh
Shayandima	1 063	353 kWh	15.47 c/kWh
Makwarela	880	350 kWh	15.58 c/kWh
Others (mainly rural)	8 891	226 kWh	16.07 c/kWh

TABLE 4.6 Average consumption and price paid by domestic consumers in Venda 1992/93

Source: Venda Electricity Corporation Annual Report 1993

The intention of the government subsidy was obviously to stimulate the use of electricity by households in Venda. Over the four-year period 1989 to 1993, the number of domestic customers increased by 243% while the domestic consumption of electricity increased by 208% in the same period. The average monthly consumption levels have not changed much, implying that it is difficult to say whether the government subsidy in fact stimulates household consumption of electricity.

The actual effect of the government's 50% domestic tariff subsidy is more likely to subsidise consumption for those households already connected to the grid, which again often turns out to be the most wealthy of the local households. This kind of subsidy cannot be regarded as equitable. If the government wanted to subsidise domestic electricity consumption it would be far better to subsidise access to electricity in the form of lowering connection charges. This will be further elaborated below.

Policy, fees and rates of connection

Since the introduction of the government domestic tariff subsidy in April 1990, considerable attention has been given to increasing the number of household connections. The introduction of the subsidy resulted in a large number of applications for connection, again resulting in a backlog of customers who had applied for connection and, in some cases, even paid their connection fee, but have had to wait a considerable period before actually being connected. In some cases, civic organisations, having collected money for the cash connection fee, were turned back due to lack of capacity on behalf of Venda Electricity Corporation (Lithole 1993). The local electricity utility charges R350 in urban areas and R380 in rural areas for connection fees, considerably higher than what is being charged by, for example, Eskom and Durban Electricity in other areas of the country. The connection fee does not include any appliances, only a ready board. So far, pre-payment meters have not been introduced in Venda. Customers are billed monthly after reading of standard credit-type meters.

The rate of connection has gradually increased over the last years. In the financial year 1992/93, a total of 2 821 new connections were carried out. The moving average has continued to increase to reach a target rate of about 3 000 new connections per year. As of end of June 1993, construction statistics show that the connection rate was up to 3 100 on an annual basis, with line construction reaching 296km, 127 new sub-stations being constructed, 10.5 new consumers being connected per km of line, an average of 2.3 kms between each new substation and with an average of 24 new consumers per substation.

This is a fairly high performance for an organisation of the size of Venda Electricity Corporation. The total staff complement is about 300, implying that 10 new connections are made per year per employee. This is about the same level of new connections per employee as for Durban Electricity, but about twice as many as made by Becor in Bophuthatswana (see Chapter 4.3.2).

According to Eskom's database of distributors, planned connections for the near future are 3 900 (in 1993), 3 600 (1994), 3 600 (1995), 4 000 (1996) and 4 000 (1997). However, a lower figure of 1 900 new connections per year for the period 1993-98 has been given by other sources within Eskom.

It should be noted that, in addition to the number of new domestic consumers, a considerable number of small power consumers are also being connected, in the same areas as household electrification is taking place. These are typically local cafés and bars, general dealers, small workshops and some schools and clinics. On average, one new small power user is connected for each 11 new domestic consumers.

Plans for new connections are based on an average cost of R4 100 per new

connection, including all HV reticulation, lines, step-down substations, LV reticulation lines and also service connections, ready board and a credit meter. The actual figure experienced for the period April 1992 to March 1993 was about R3 600 per connection. This figure has been quite stable for the last three years, after having experienced costs of about R5 500 per connection in the early period after the introduction of the government tariff subsidy in April 1990.

The DBSA is Venda's main source for financing electrification. It contributes approximately 2/3 of the capital requirements, with the remainder being operating surplus from Venda Electricity Corporation, *after* inclusion of the government subsidy in the revenue accounts. While the accounts for 1993 showed an operating surplus of about R2.4 million, the actual result without the government subsidy would be negative by R4.0 million. Loans granted by DBSA normally carry 11% interest and a grace period of five years. Outstanding loans from DBSA amounted to about R13.6 million by March 1993. As Venda Electricity Corporation was created only in 1987, this implies that the real effect of repaying the loans from DBSA has not yet made its impact on the accounts of the electricity corporation. Hence, continuing electrification at the present tempo, without improving the revenue side, might quickly lead the utility into considerable financial problems. In addition to the loans from DBSA, the utility has a R3.3 million loan from Standard Bank of South Africa, for the construction of a head office in Thohoyandou in 1988.

Future development of electrification in Venda appears uncertain. Considerable doubt can be raised about the continuation of the 50% government tariff subsidy on domestic consumption, particularly taking into account that the subsidy amounts required will increase quickly in line with the number of new consumers.

However, VNDCED still state their development objectives as 'that of promoting economic development in Venda and to raise the living standards of local inhabitants by implementing a phased and balanced, economically rational electrical consumer expansion programme while adhering to cost-recovery principles, and taking cognisance of possible future regional development trends.' It might be hard to achieve the stated objectives.

An indication that VNDCED is also starting to realise this might be found in a statement made by the Assistant General Manager of VNDCED in communication with Lithole (1993): 'Priority will now be given to connection of non-domestic consumers who are not subsidised and to broadening the revenue base through connection of new bulk consumers to the network.'

4.3.4 The situation in other 'homeland' areas

Some information is provided below about the situation and the tariff systems applied in Gazankulu and Transkei, two 'homeland' areas where the electricity distribution authorities have experienced considerable financial problems.

Gazankulu

This 'homeland' area is being supply by Gezicor, a joint-venture organisation owned by Eskom (50%) and the local Gazankulu government (50%).

According to information from Gezicor (personal communication of 24 March 1993), the total number of domestic consumers in February 1993 was 4 272, of which 3 418 (80%) were in urban areas and 854 (20%) in rural areas. Access to electricity in Gazankulu is considerably lower than in, for example, Venda (which has a similar population size and population density), particularly in rural areas. Recorded consumption levels are also lower than in Venda, with average monthly consumption amounting to 457 kWh in urban areas and only 133 kWh in rural areas. The domestic tariff is 9.70 c/kWh (incl. VAT). Gezicor's tariff revenue per kWh sold (incl. VAT) is, however, 20 c/kWh, as the government of Gazankulu subsidises domestic electricity consumption by 10.30 c/kWh. The average connection cost for

new domestic consumers is stated to be about R4 000 and the target for new connections to be 3 000 per year. No information is available about the connection fee charged to new consumers. The connection target appears quite unrealistic (at least in the short-to-medium term) when considering the existing number of domestic customers and the financial problems of the Gazankulu local government. However, negotiations are about to be completed on a full Eskom take-over of supply rights in Gazankulu, which might improve the situation considerably.

Recent information from Eskom (personal communication October 1993) indicates that the number of domestic connections in Gazankulu now stands at about 10 000 and that the customers are now charged with Eskom's standard S (pre-payment tariff), C (metered urban domestic tariff) and D (metered rural tariff) tariffs.

Transkei

Most households in Transkei (particularly in rural areas) are supplied by Tescor, a 'homeland' authority with considerable financial problems. Umtata and Bizana are supplied by municipal distributors while Herschel and Sterkspruit are supplied by Eskom. The number of domestic electricity customers in Transkei is about 11 000, implying that only approximately 2% of the households in Transkei have access to electricity from the grid. As of 31 March 1993, Tescor supplied 6 700 domestic customers (of the total estimated at 11 000).

Tescor's operating result for the financial year 1992 was negative with about R2.5 million, with an even larger negative cash flow. The Transkei government has asked Eskom to take over supply in Transkei, an issue which is presently being analysed by Eskom. The most recent information, however, indicates that Eskom is rather unwilling to take over supply in Transkei due to large investment needs for development of a transmission (and distribution) system for Transkei.

Domestic tariffs in Transkei prove to be a good example of the fragmented and unclear tariff structure in the electricity distribution industry. As from April 1993, Tescor has six different domestic tariffs: standard (T4), reduced connection fee (T5), prepayment (T6), surcharged standard (T12), surcharged reduced connection fee (T13) and surcharged prepayment (T17). The surcharged tariffs relate to customers in the areas of Mt Frere, Mt Ayliff and Tabankulu connected by Eskom on behalf of Tescor. These customers are surcharged at 20% for a period of five years to pay back the Eskom connection fee for these areas. Until 1992 a separate tariff also existed for domestic consumers supplied by diesel generators.

The standard metered domestic tariff (T4) comprises a fixed monthly charge of R23.32 plus an energy charge of 15.80 c/kWh (both including VAT). Until 1992 the energy charge had the form of a declining block tariff, but this was changed from 1993. Customers connected by the T4-tariff are charged a connection fee of R855 (including VAT). The reduced connection fee tariff (T5) has the same monthly service charge, but a higher energy charge of 19.83 c/kWh. These customers pay a connection fee of R114. The prepayment tariff is also quite special, with the unit charge being 15.80 c/kWh, but with a transaction fee of R25.00 for each time a new card worth R35.00 is purchased. This card provides for a consumption of 221 kWh and is apparently the only denomination of the pre-payment cards used in Transkei. Total expenses of R60 every time electricity is being purchased must be regarded a heavy burden on the small household budgets of poor rural households.

4.4 Non-household electrification in rural areas

While the focus of the EPRET study is on the energy use of households, the electricity situation in rural areas is such that, if an RE programme is to be sustainable, other loads than households' need be built up quickly. Thus it is incumbent upon the design of an RE programme for rural households to look for such other loads. Such loads are to be found in two areas:

- local production requirements (commercial¹ and agricultural²);
- community institutions (schools, clinics, community halls etc).

In this paper we shall not discuss the electricity requirements of production establishments, but will in this section discuss briefly the electricity requirements of community institutions. What makes the electrification of rural institutions important in the context of a programme for electrification of rural households, is that a coordination of the two would increase loads, and hence make an RE programme more financially feasible. This contribution should not be under-estimated, as such institutions can also attract a wide range of alternative funding,

The financing requirements of rural community institutions' electrification are not included under the costing scenarios for the RE programme discussed in Ch. 6. The financing of electrification of rural community institutions is expected to be covered under appropriate government budgets, be it central, regional or local. As long as the new South African government structure is under discussion and negotiation, it is very difficult to be more specific here. It should, however, be possible to look at a 'globalisation' of budgets also in this case (see Mabongwa & Muller 1992: 14).

The Independent Development Trust (IDT) is involved in an electrification programme for community institutions as follows:

IDT ... is prepared to allocate some R50 million during the 1993-94 financial year, for promoting electricity supply to rural community facilities in impoverished areas of South Africa. The present focus is on clinic electrification, in tandem with IDT's broader clinic building and upgrading programme. The scope of IDT's support for RE, however, is expected to extend to selected schools, community centres, public service offices, community water pumping – applications which, in principle, can benefit not just the richer members of a rural community, but the very poor as well. (EDRC 1993: 1).

The following caveat concerning IDT's mandate is of interest:

...to support communities where there is greatest need – and often 'worst opportunity'. Other funders (e.g. loan funders) may be directed more towards 'best opportunities' for productive or cost-recovery outcomes. IDT's contribution could distort an overall national RE strategy if it were mistakenly viewed as fulfilling national responsibility for a balanced spectrum of RE support. On the other hand, joint participation by different subsidising institutions could lead to a complementarity of purpose. (EDRC 1993: 13).

IDT observe the following principles in their electrification programme:

- Grant assistance with capital costs of grid extension through block grants to the utility against performance targets.
- Remote Area Supply alternatives (RAPS) for locations where the costs of grid supply are currently too high through subsidisation of both the capital and maintenance components through a joint maintenance fund. (Viljoen & Cross 1993: 17)

1. A description of typical non-household productive activities requiring electricity in seven rural villages on the LouisTrichard/Thohoyandou route in Venda (Lithole 1993: 22) is as follows: 'Each village has an average of three cafes, two general dealer shops, five workshops, two secondary schools, three primary schools and a fruit market along the tar road.... Small business activity is also thriving.'

2. Concerning electricity and small-scale agriculture, Auerbach & Gandar (Ch. 8) conclude that: 'Co-ordination between agricultural development programmes and electrification programmes is essential. All possible opportunities for agricultural and associated developments to sustain grid extensions should be identified. Nevertheless, the extension of the grid in the homelands is unlikely to be agriculture-driven to any notable extent.' (Emphasis added)

4.5 Ongoing electrification in rural areas – some concluding remarks

The analysis in this chapter of the ongoing electrification programmes carried out by Eskom, major municipal distributors and the 'homeland' distribution authorities clearly illustrates that the present picture of RE in South Africa is a complicated and fragmented one. In many cases a clear definition and understanding of RE is missing.

RE is still in its infancy in South Africa, with Eskom gradually becoming the most important distributor in rural areas. Eskom's key position will become even more pronounced with the ongoing take-over of supply rights in 'homeland' areas.

Electrification of rural centres and dense village-type settlements appear to be a trend among those distributors that have a RE programme of any significant size, including electrification of local community facilities and small-scale commercial enterprises where such exist. Farmworker households on commercial farm land, on the other hand, do not appear to be a major target in Eskom's electrification programme, although it is likely that this household category can be electrified within acceptable cost ranges and with the active support of the farmer community.

Important problem areas are the widely differing practices with regard to connection policies and connection fees charged to customers, tariffs charged for rural electricity supply and local government policy for subsidising electrification. The latter is particularly related to the situation in some 'homeland' areas where government subsidy of the energy tariff is common. This is, in fact, a subsidy benefitting existing consumers more than new consumers and, as such, not very equitable when discussing household access to electricity.

The current structure of the electricity distribution industry in rural areas is an obstacle to a rapid and large-scale RE effort, particularly in former 'homeland' areas. Although some 'homeland' distributors are doing fairly well and operating according to financially sound practices, the general situation of 'homeland' distributors is quite bleak in financial terms. It is quite clear that a major restructuring of the electricity distribution industry in 'homeland' areas will take time, both because Eskom needs time to assimilate the former 'homeland' distributors within its own organisation and because considerable unresolved problems persist with regard to future local government organisation and responsibilities.

Altogether, the analysis of ongoing electrification in rural areas proves that a major RE programme is only possible when looked at in a long-term perspective and rooted on local involvement. It will require financially viable electricity distributors with consistent policies and approaches regarding connection of new customers and the charges to be applied for connection as well as use of electricity.

The framework for future rural electrification

5.1 Programme time horizon and priorities

It has already been emphasised that a major rural electrification (RE) programme must have a long-term time horizon. Experience from Southern Africa, as well as other parts of the world, indicates that it takes a considerable period of time for rural people to get used to the virtues and advantages of electricity as a major energy source and to acquire affordable appliances. Hence, it takes time before consumption reach levels which makes cost recovery possible for the electricity utilities responsible for the supply. A major RE programme should also be phased in together with a new government's long-term policies for rural development. Electrification should be used actively as a catalyst to support and enforce other development initiatives aimed at stimulating economic and social development in rural areas of South Africa. Those responsible for the RE programme should liaise with other rural developers, either public, private or NGOs, and only embark on major RE efforts after the necessary coordinated analysis and planning has taken place. Such liaison may prove extremely time-consuming; an increase in planning resources would be needed to avoid a considerable possible bottleneck developing.

Having taken into account the above arguments, it is recommended that a national RE programme should have a time horizon of at least 15-20 years, with initial priority being given to support for development of rural growth-points (both local public service provision and households) as well as electrification of farmworker households. The emphasis on farmworker households is justified because of the relatively lower connection costs involved in electrifying this group, while electrification of households in rural centres with identified growth potential is justified by taking a broader view on how future socio-economic developments should take place in rural areas of South Africa. Remote rural households should not be a priority in the short-to-medium term, due to the very high unit costs involved in grid extension to such potential consumer groups and the relatively low monetary incomes of these rural households. Some remote rural households could, however, be the targets for electrification based on RAPS technologies, particularly in areas very remote from the electricity grid, but where an economic development potential has been identified. Actual guidelines for how RE based on RAPS solutions should be carried out is not discussed any further.

5.2 Level of ambition and targets for future RE

In order for an electrification programme for households in South Africa to be equitable, a considerable effort will have to be made to electrify rural households. After all, the rural population accounts for about half of the total South African population (but only about 42% of the households due to a larger household size in rural than in urban areas). This is a substantial argument for making rural areas a major target for future access to electricity, taking into account that electricity is an important factor of social well-being and development opportunities. On the other hand, it must be clearly recognised that rural electrification is very costly in financial terms and so will have to be seen as a long-term development ambition and commitment of the government. An RE programme should, however, also be closely linked to the actual energy priorities, requirements and supply options of the rural population.

A number of ambitious targets have been put forward for a electrification programme for South Africa. The most optimistic and ambitious political forces and stakeholder representatives have been talking about electrifying as much as 80% of South African households within the next five years. Such an ambitious programme is hardly realistic, and would imply non-sustainable levels of public spending and have dramatic negative impacts on the financial viability of the electricity distribution industry (EDI). Using government funds of such a magnitude for electrification alone would also have severe budgetary consequences for other development areas like housing, health, education, public transport, and social security, where the new South African government will have to embark on major public investment and expenditure programmes.

A more realistic, but still ambitious, target is the goal of electrifying about 85% of all households by the year 2010. This is the basis for the integrated energy planning scenario presented by the EPRET project, to be discussed more in detail in chapter 6.2 of this paper. Accepting such a scenario would imply that an estimated 60% of all rural households would be electrified by 2010, the highest coverage being farmworker households of which about 80% would have access to electricity by this time, while less than 30% of households in remote rural areas would have access to electricity. Households in what is characterised as dense rural areas (rural villages and other settlements) should also be given considerable attention in the early phases of such an RE programme, to support and build on the efforts presently undertaken by major EDI players like Eskom and Durban Electricity.

The suggestion in this paper is that a major RE programme for South Africa should have two primary target areas: the farmworker households; and the large number of rural villages and dense settlements in the areas of the TBVC states and the former self-governing territories (SGTs). Average population densities in these areas are given in Table 5.1.

Rural farmworker households are mainly located on commercial farmland, where population densities are lowest. Population densities are considerably higher in other areas of South Africa, particularly in the former SGTs and in Ciskei. A major part of poor South African households live in these areas, often in quite dense settlements. Such dense rural areas should be a primary target for a major RE programme, in order to alleviate some of the politically negative effects of the former apartheid government. These rural villages will also often be potential local 'growth-points', where electrification could be viewed as only one element of a comprehensive integrated rural development effort to improve the living conditions of people and to stimulate local productive activity and income-generation. Electrifying such areas first, starting with local institutions like schools, clinics and various government offices and other public needs like village lighting, appears to be the most prudent approach to a major RE programme for South Africa. Such an approach would probably reduce the financial costs of the RE programme in the medium-to-long term, because a population shift to more dense areas might be induced by the RE and other development programmes targeted at dense rural settlements. This is also consistent with experiences gained in some neighbouring countries like Botswana and Namibia (Dahl & Horvei 1993). Giving priority to certain dense rural settlements and farmworker households will be consistent with, but further enforce, present dynamic RE activities of the EDI. If a new government decides to commence a major RE programme with ambitious targets, it will be important to actively cooperate with the EDI to ensure that all forces pull in the same direction.

Area	Total population (in millions)	Population density (persons/km ³)
Transkei	3.1	71
Bophuthatswana	1.9	48
Venda	0.5	71
Ciskei	0.8	98
Gazankulu	0.7	96
Kangwane	0.6	153
KwaNdebele	0.4	192
KwaZulu	5.0	138
Lebowa	2.7	120
Qwaqwa	0.3	282
SA (excl. TBVC & SGTs)	21.0	20

TABLE 5.1 Population and population densities in 'homeland' areas in 1989/90

Source: DBSA Statistical Abstracts 1989 (for SA and TBVC) and 1990 (for SGTs)

5.3 Criteria for design of a major RE programme

While electrification of farmworkers (in RSA) is expected to move reasonably quickly, at least for those who are employed on farms which already have electricity, the real challenge of RE is to be found in rural areas *outside* of the present RSA: in the TBVC states (Transkei, Bophuthatswana, Venda and Ciskei) and the SGTs (Gazankulu, Kangwane, KwaNdebele, KwaZulu, Lebowa and Qwaqwa). The present income sources and trends in rural areas have been summarised qualitatively in Table 5.2. Earnings are to a large extent dependent upon external (political) factors and are at best stable or declining. This is a background for the discussion of individual TBVC and SGT states to follow below.

Type of income	Comments
Pensions	Stagnant, perhaps falling in real terms
Private transfers	Falling
Small-scale production	Stagnant; presently about 5% of family incomes; limited potential
Govt welfare subsidies	No comment
'Homeland' incomes	Stagnant

Table 5.2 Sources for and income trends in rural areas
Source: DBSA (personal communication) 1993

Population size and density figures are presented in Table 5.1, showing a large spread in population size, with KwaZulu and Transkei the most populous, and a series of small ones like Qwaqwa, KwaNdebele, Venda and Kangwane. When it comes to population densities, the highest are found in Qwaqwa, KwaNdebele, Kangwane and KwaZulu; with Bophuthatswana, Transkei and Venda at the lower end. Higher densities augur lower costs of an electrification programme; therefore those just mentioned might come high on a list of priorities, having about 40% of the combined TBVC and SGT population. Electrification in the high density areas (all SGTs) has, however, not been a success. Presently, Eskom (and in KwaZulu also Durban Electricity) has taken over, or is about to take over supply rights in most areas except for Qwaqwa (see Table 3.7).

The per capita monthly personal incomes (Table 5.3) of the various states are all low, but show a considerable spread, with Transkei at the top and Venda at the bottom. Those with highest monthly personal incomes are Transkei, KwaZulu and Qwaqwa.

Area	Per capita personal monthly income, Rand ¹	Infant mortality rate ²	Life exp. at birth, (years)	Literacy rate ³	Children not at school (in %)
Transkei	128	90	55	66.0	14.1
Bop'tswana	87	50	63-68	60.5	20.9
Venda	59	57	65	56.3	12.5
Ciskei	83	50	65	70.1	10.2
Gazankulu	59	45	65	56.0	12.5
Kangwane	92	55	63-67	56.0	10.3
KwaNdebele	71	49	62	52.0	10.5
KwaZulu	101	52	61	61.0	17.0
Lebowa	77	68	59-63	62.0	11.1
Qwaqwa	96	63	62	66.0	8.3

Table 5.3 TBVC states and SGTs: Some socio-demographic parameters

Source: DBSA. 1990, 1991, 1992

Notes:

1. TBVC States 1989, other 1990.
2. Per 1000 live births.
3. 13 years and older with Std 4 and higher.

When it comes to socio-demographic 'performance' the high infant mortality rate of Transkei (90) is noted. Life expectancy at birth is high (63-68 years) in Bophuthatswana and Kangwane, and low in Transkei. When it comes to the literacy rate, Transkei, Ciskei and Qwaqwa score higher than the others. Concerning the share of children going to school, Ciskei, Kangwane, Lebowa and Qwaqwa all have a participation rate of about 90%.

If electrification is to be carried out purely from the point of view of promoting social welfare (education and public health), Transkei, Lebowa, KwaNdebele and perhaps KwaZulu would receive priority.¹

Area	High density of population criterion	Higher income criterion	Higher welfare needs criteria
Kangwane	★	★	
KwaNdebele	★		★
KwaZulu	★	★	★
Qwaqwa	★	★	
Transkei		★	★
Lebowa			★

Table 5.4 Rural electrification requirements based on population density, income and social welfare criteria

Source: DBSA. 1990, 1991, 1992

1. 'Regional allocations, from the budget, could be apportioned on the basis of population, density, the numbers of clinics and schools; and indicators of need, such as the numbers of schools and clinics per capita, infant mortality rates, and literacy rates. On such criteria (weighted), regions such as KwaZulu, Transkei and Lebowa stand out as high-need areas.' (EDRC 1993: 11-12).

Thus certain TBVC and SGT states, for various reasons, are priority areas for rural electrification.

Following from the above, design criteria for rural electrification would be to choose areas with:

- (i) high population density;
- (ii) higher household incomes;
- (iii) higher welfare needs.

Electrification according to criterion (iii) would point towards concentration of the electrification effort on public institutions like clinics and schools and would, in particular, require support from the fiscus, while the two first would apply to electrification of *households*, using cost-reflective tariffs.

Other more general criteria for choice of areas for electrification of rural households would be:

- (iv) to avoid areas with particular difficult topography;
- (v) to avoid areas with long distance from existing grid.

Both of these point to factors which, if not avoided, would increase unit costs of connection unduly.

- (vi) Choose areas with an income potential and with good strategic location with regards to communications and access to water;
- (vii) choose areas which already have public institutions (schools, clinics) or with such institutions in the pipeline.

5.4 Electrification as part of integrated rural development programmes

Electrification of rural areas is an agent for modernisation and socio-economic change. It would influence the way households live, how they would spend time. Electrification is, however, only a necessary condition which does not alone guarantee that complementary development activities would take place. If, however, pre-electrification cash incomes in a rural area would not be sufficient to warrant the load growth required for cost recovery (at a given tariff) of household electrification expenses, a substantial RE programme could be compared to a shooting star: its brightness cannot be sustained. Hence, it is important also to phase in new income-generating activities, providing rising incomes for the warranted household load growth, but also allowing for *additional* load growth to improve financial sustainability of rural electrification.

Thus, it cannot be overemphasised that an *integrated* approach to create income growth and development in rural areas would be required as vehicle for promoting sustainable electrification. There is one great problem, however: the great size and density of the rural population, which cannot be sustained through agricultural activities, but requires welfare payments. Presently rural incomes are not increasing, - are even, perhaps, declining (DBSA personal communication). This raises the importance of land reform (in commercial farming areas), the financing of such a reform and how many households could be gainfully settled on such land (Mbongwa & Muller 1992: 7, 11-13). Furthermore, Mbongwa & Muller (1992: 15) also mention the possibility of 'selective disinvestment from those areas where occupation is not sustainable'. To some extent this is not different from our proposal below that rural electrification start with electrifying rural centres, growth points, nodal points - that is, points which could conceivably emit above-average economic gravitational pulls on the surrounding areas.¹

1. A DBSA discussion paper (Kritzinger-van Niekerk et al: 1992: 27) claims that: 'Black townships include approximately 22 informal sector businesses per 100 households.' In time, a pattern of small (non-agricultural) household businesses could probably also develop in rural centres, given the availability of electricity and a certain size of population.

Land reform aside, what could be done? Under different budgets of government departments (such as agriculture, roads, health, education, industry), there will be financial resources available for (social) infrastructure investments in rural areas. (More or less the same point has been raised elsewhere (Mbongwa & Muller 1992: 14) under the heading *globalising and reorienting the agricultural budget*, drawing on an analogy with the De Loor Commission's work concerning housing policy.) Such 'globalised' government investments need to be synchronised in time and space.

Where a rural settlement has been selected for the erection of a school or health clinic, electricity development should join in at an early stage. Perhaps one might also consider what kind of commercial agricultural (and other productive) potential a settlement might have. Perhaps water-pumping – assuming the availability of a water source – using electricity could be financially sustained through sales of agricultural produce. If so, electricity development should take place early on at such a location. In choosing the actual rural centres to be electrified, local characteristics like access to a reliable source of water, access to an all-weather road – existing or planned – need to be identified.

5.5 Some principles for successful rural electrification

Thom (1993) has proposed some principles that should guide an RE programme in order to achieve greater equity in access to electricity without undermining sustainability. Each of the proposals are briefly discussed below.

- (i) *'The electricity policy formulation and planning processes should be structured to ensure real inputs to decision-making by representatives of rural communities.'*

This principle is aimed at ensuring stakeholder representation in the planning of RE programmes, but also active involvement of local rural committees in the detailed planning and implementation of RE projects. This seems to be the approach followed by Durban Electricity in the Valley of a Thousand Hills, where we participated in a meeting with a local electricity committee. It was quite obvious that this committee was actively providing constructive criticism and feedback both to the contractor and to representatives of Durban Electricity.

- (ii) *'The electrification of all operational and planned rural community facilities which require energy services should be the primary objective of a RE programme.'*

This principle strongly supports the belief that RE should be designed with a clear focus on local user needs. Electrification of local community facilities like schools, clinics, water supply, village lighting and community halls, will be of benefit to the majority of the rural population in the areas and as such equitable.

- (iii) *'Restrictions should be placed on the (maximum) cost allowed per connection, but all rural communities should be given the opportunity to negotiate local contributions or different levels of supply service in order to gain access to electricity.'*

This recommendation is linked to the concept of a nationwide tariff that must be affordable to all consumers, while at the same time ensuring that the operations of the supply utilities remain financially viable. Different maximum connection costs could be set for different types of rural consumers. Separate maximum connection cost targets have, for example, been proposed for farmworkers, dense rural settlements, and remote rural settlements. Community contributions to cover costs in excess of these targets could be in the forms of cash or contributions in kind, as well as requests for a reduced level of service with consequent reduced service and maintenance costs for the supply utility.

- (iv) *'The price of electricity services should be structured to reduce the barriers of access to the poor.'*

This principle covers two different aspects: the cost of use, and the initial cost of access. It is clearly recognised that there is a need for applying pricing systems where the initial connection cost is recovered over time through the unit tariff paid by the consumer.

Applying a straight-line national tariff for domestic users will effectively ensure a cross-subsidisation from high-level consumers to low-level consumers, and as such contribute to lowering the barrier of access for the poorer part of the population. An actual payment for the initial connection should, however, still be retained as a signal of value. Present examples of such arrangements are Eskom's initial cost of R35 per connection and the fee of R142.50 charged by Durban Electricity. (The latter fee includes payment for a hotplate, valued by Durban Electricity at about R100, intended to increase consumption level as soon as the new consumer is connected.)

To the above may be added some further principles:

- (v) *That labour-intensive solutions should be used for line construction, using labour from the locality where the electrification actually takes place.*

This approach is used both by Durban Electricity and Eskom Natal in their electrification projects in KwaZulu (Valley of a Thousand Hills).

- (vi) *That operation and maintenance, as well as technical support should be designed in such a way as to use local labour. Such labour needs to be trained and the arrangement would leave a part of the local tariff payments behind in the local economy. The authors noticed that this approach was not, so far, being considered by Durban Electricity or by Eskom Natal, which intend to use their normal staff to service rural areas.*

- (vii) *That the use of local expertise could also involve community-based organisations (CBOs) and locally-based NGOs.*

In this connection we may note what Foley (1989: 154) concludes:

NGOs have an important role to play in rural electrification. They can facilitate dialogue between local communities and rural electrification agencies; they can carry out community level research into the role electricity can play; they can assist in the development and testing of off-grid systems. They can also help in the promotion of the use of electricity uses and the education of local communities into how it can be used to raise their standard of living and promote their economic development.

It should be emphasised that the kind of NGO referred to by Foley needs to be locally respected and have a good local track record.

5.6 Financing requirements and options

Household electrification (both urban and rural) can, in general, be financed by (a) the consumer paying for the reticulation and connection costs in cash; (b) including costs in the cost of constructing a new house and paying for it through a mortgage loan; or (c) it can be paid for through a tariff system where costs are recovered by the tariff over a certain period of time (often 15 years or more) and through an estimated average consumption level (generally set at about 350 kWh/month). For poor households, particularly in the rural areas, only the last option appears realistic. Cash holdings are rare, and access to mortgage finance difficult. An

exception might be situations where the government supports construction of houses as part of an integrated rural development programme.

When the cost of RE is to be paid for through the tariff, this assumes that the electricity utilities involved have the financial capacity to carry the initial costs until these are repaid over time through the tariff paid by the consumers. This situation might quickly jeopardise the financial viability of the electricity distribution industry – with the possible exception of Eskom and a few large (white) municipal authorities. However, even for Eskom and other financially strong utilities, advancing the costs of RE against future repayment through the tariff system might easily result in the electricity utilities giving priority to electrification of new consumers in urban and peri-urban areas where connection costs are lower, household incomes higher and the expected consumption of electricity higher than in the rural areas. This would inevitably sooner or later result in a situation where little or no RE takes place – a development that would conflict with the overall policy objective of equitable access to electricity across various groups of household. It appears, therefore, to be necessary to have a specific government policy for RE in order to avoid such a development. This policy must be followed by a proven willingness to put up financial resources to alleviate the situation described above for the electricity utilities.

Some general principles have been proposed by Van Horen (1993) regarding financing of household electrification programmes in South Africa. These principles apply to electrification in general, but are also relevant for financing of rural electrification:

- (i) Financing and pricing policies should maintain the financial viability of electricity utilities.
- (ii) Public finance is necessary where private funds are inadequate.
- (iii) External subsidy finance [should] be applied first to reduce capital costs for all [new] connections.
- (iv) Cross-subsidisation is important as it can help achieve equity goals while maintaining overall cost recovery and financial viability.

The principle of maintaining financial viability of electricity utilities should also apply to RE programmes. The advantages of having a financially viable electricity distribution industry will not be discussed further here, but is elaborated in EPRET papers by Van Horen (1993) and Steyn (1993). Recognising that the costs of electrification in rural areas are generally higher than the expected revenues from electricity sales in these areas, at least in the short-to-medium term, this does not necessarily mean that electricity utilities should not engage in RE activities. Utilities will generally be in the best position to plan and administer RE programmes, as they have the necessary competence, planning capacity and organisation to handle this task. They also have the possibility of cross-subsidising rural consumers from other consumer groups. This will result in a more equitable treatment of the various consumer groups with regard to access and use of electricity. Cross-subsidies can be designed in such a way that, while ensuring that equity objectives are met, the overall cost recovery objectives and the financial viability of the utilities are met at the same time.

However, the government should on its side recognise that there will probably be a need for a certain amount of public finance to cover the extra costs of a major RE programme. Where EDI finance is not sufficient, public finance must be brought to facilitate the implementation of a major countrywide RE programme.¹

1. For example in Taiwan (the Republic of China), where the government's direct contribution has varied between 15% and 47% over a period of 38 years (Taiwan 1991: Table 1).

5.7 The role of government and public finance in RE

Public finance will usually take the form of subsidies in one form or another. The main objective of such finance should be to stimulate the access of the rural population to electricity supply. The actual choice of energy supply mix should, however, be determined by the rural consumers themselves, on the basis of relative energy prices based on cost recovery principles and according to the individual income and preferences of the consumers.

5.7.1 Some guiding principles for subsidies for household electrification

Recognising that subsidy finance might be necessary for implementation of a major RE programme (as, for instance, in the Republic of China) some basic principles for sourcing and allocations of subsidies are proposed:

- Access to electricity (connection costs) may be subsidised, not the use of electricity (consumption). This follows from the 'widening of access' principle in EPRET and would mean that households would receive financial assistance with the connection fee.
- The government (fiscus) must commit and sustain subsidies (capital transfers) to the utility under a *contract plan arrangement* (Steyn 1993: Ch. 4.3), for as long as would be required to provide equitable access to electricity for rural households. Electrification of rural households is concerned with equity and with the socio-economic development of the poor in less privileged areas. For rural electrification to succeed 'in our time', extra financial resources, in excess of what could be made available through cross-subsidies within the electricity distribution industry (using part of its operating surplus from supply of other consumer groups), would be required to cover capital and financial costs. Only the government would be able to provide the extra amounts required for the necessary duration.
- Government subsidies to the utility for the purpose of providing access of rural households to electricity will be made through a *specific government budget line item*, and shown as a specified income item in the utility accounts. This principle has to do with good governance, and implies transparency of subsidy payments from government to utility, but would also apply (*mutatis mutandis*) to payments from utility to government in connection with a possible consumption 'equalisation levy' on bulk generation, collected by the utility. The same transparency principle would also apply if rural capital subsidies (grants or soft loans) were to be received from abroad, earmarked for rural electrification.

Government priority policies would normally be supported operationally through the budget, using government expenditure programmes as a tool for reaching policy targets. Alternatively, or in combination, government might also directly regulate the use of a power utility's operating surplus – assuming there is one – through regulating the kind of financial instruments admissible in the utility's financial portfolio.

In several SADC countries (such as Zambia and Zimbabwe), initial RE efforts have faltered and stopped because government's financial support of its RE programme has been minimal and has come to a halt, and because the financial viability of the supply utilities have been gradually sapped through governmental unwillingness to approve timely and sufficient tariff increases in the face of steadily increasing utility costs (Dahl and Horvei 1993). A combination of the two instruments may be used to support any RE programme financed by the utility – unless foreign grants should become available.

Consequently, for a RE programme to succeed, the government's role in financing RE programmes must be pro-active, both through allowing for a sufficient budget

line item in the development (capital) budget, repeated as long as RE has a high priority, for support of power line development in rural areas. In addition, the government must adopt a 'hands-off' posture vis-à-vis the supply utility's day-to-day operations, allowing for it to set cost-effective tariffs to secure a fair return on the capital employed and, thus, allowing it to generate an operating surplus. The surpluses thus generated might then – wholly or partly – be ploughed back into a RE programme – this would, however, be a matter for the utility's owner(s) to discuss through the appropriate governing body.

The utility might, however, by itself decide to reinvest part of its surplus in RE programmes, as a long-term commercial investment (as Eskom is currently doing), perhaps with some government capital support for a gearing-up of resources available. Alternatively, a compact between utility and government might be required, through which a certain part of the utility's operating surplus would be allocated to RE. A stricter measure would be for the government to tax utility surpluses (as recently proposed in Namibia) or oblige the utility to place a certain amount of its surplus in government (rural electrification) bonds. The government should in any case allow the utility to set cost-reflective tariffs to guarantee required financial viability, while the government on its side should draw up certain tariff principles – such as flat-rate nationwide tariffs (see Pickering 1993) – as part of its coordinating RE role.

5.8 Electricity distribution industry restructuring – implications for RE policies and programmes

It is generally recognised that there is a need for a restructuring of the electricity distribution industry (EDI) in South Africa. A target often mentioned is a reduction in the number of authorities with supply rights from more than 400 to 4-15 large regional distribution utilities. This process will take time and is closely linked to the process of reforming local government institutions in South Africa.

In order not to lose momentum, it has therefore been suggested (Van Horen 1993 and Steyn 1993) that the proposed electrification programmes (for both urban and rural areas) should be carried out without waiting for a reorganisation of the EDI. In order for this to happen, some proposals have been put forward as to how the EDI should act in this interim period in order not to reduce the speed of the electrification programme:

- (i) Local authorities with financial and technical capacity to carry out electrification programmes should be allowed to go into new supply areas originally controlled by black local authorities (BLAs) in order to electrify new households.
- (ii) Eskom's current incentive schemes, through which Eskom is providing financial incentives to other distribution authorities based on the number of new connections they carry out, should be continued – or even extended and improved.
- (iii) Eskom should be given the right to continue to negotiate take-overs of BLAs and other weak local distribution authorities, both within its existing regions and in the 'homeland' areas. The conditions for such take-overs of supply rights should be as fair as possible in order to facilitate the future necessary reorganisation of the EDI.

5.9 The future RE framework – a brief summing up

- The time horizon for a major South African RE programme will be at least 15-20 years, with initial priority being given to support development of rural growth points (both local public service provision and households) as well as electrification of farmworker households.
- Cooperation with local community structures in electricity project formulation and planning is essential.
- Access to electricity (connections) should be subsidised, not the use of electricity.
- There should be a national straight-line tariff.
- Least-cost supply solutions should be adhered to.
- Restrictions should be placed on maximum allowed cost per connection, but there should be an opportunity for local communities to negotiate contributions or different levels of supply service in order to gain access to electricity.
- A national service cost parameter must be established.
- The government must commit and sustain subsidies (capital transfers) to the utility under a contract plan arrangement.
- There must be a specific RE government budget line item.
- While the electricity distribution industry gets restructured, efficient local distributors and Eskom should be allowed to go into areas (through negotiated take-overs or cooperative arrangements) where they have no formal supply rights.
- In order for sufficient loads to be built up more quickly, an RE programme should also identify unelectrified social (and other) institutions in rural areas with an identifiable load.

Scenarios for rural electrification in South Africa

6.1 Basic assumptions

The EPRET project has analysed household energy policy in terms of two scenarios for the future development of energy supply options – the 'business as usual' (BAU) scenario and the 'integrated energy planning' (IEP) scenario. The quantitative assumptions applied in the BAU and IEP scenarios should not be taken as prescriptive plans or forecasts, but rather as examples of how to quantify future developments, given that certain household energy policy options are pursued. In this paper, we will look only at the scenario assumptions related to the electricity sector, and, in particular, aspects related to electricity provision for rural households.

With regard to the electricity sector, the BAU scenario is based on the assumption that little progress occurs in developing a framework for national electrification; for example, that the electricity distribution industry (EDI) is not adequately restructured and that financial constraints prohibit accelerated electrification. The IEP scenario assumes that significant progress is achieved with regard to industry restructuring, that government support for electrification is forthcoming, and that the electrification of households proceeds rapidly.

A common set of demographic assumptions has been applied for both scenarios. The EPRET household figures for 1990 and the assumptions regarding access to electricity in each household category (See Table 3.1) have been updated to the beginning of 1993. In 1990, it was assumed, the total number of households was 7.6 million and 37% of these had access to electricity. It is assumed that the following developments took place during 1991 and 1992:

- New household formation, at an annual rate of 2%, amounts to about 150 000 new houses per year for 1991 and 1992, raising the total number of households to 7.9 million in 1993. In the absence of detailed data on how this household formation actually took place, the increase has been split equally between three housing categories: informal planned, informal unplanned and backyard shacks;
- A total number of about 250 000 new connections were made by the electricity distribution industry during 1991 and 1992. It is assumed that 70% of these were in formal low-income households and the remaining 30% in informal planned settlements. The number of connections made in rural areas were quite limited.

The above developments in housing stock and electrification of dwellings indicate that about 39% of all South African households had access to electricity by the beginning of 1993, while 61% (about 4.85 million) did not have electricity. The status per household category is presented in Table 6.1.

According to Table 6.1, about 3 million rural households did not have access to electricity in 1993. This implies that only 200 000 rural households had electricity – about 6% of the rural population in South Africa. Assuming that the rate of household formation continues at 2% per year and that a total of 300 000 new connections are made by the EDI during 1993, the overall access to electricity will increase to about 41% by the end of 1993 and the access in rural areas to about 7% (assuming that about 10% of new connections in 1993 are made in rural areas).

Assumptions regarding consumption levels and connection costs for each household category to be included in an electrification programme are given in Table 6.2.

Household type	No. of households (1993)	Access to electricity (1993)	Households without electricity
Formal mid-to-high income	2 100 000	100%	0
Formal low income	800 000	72%	225 000
Informal planned shack	600 000	12%	530 000
Informal unplanned shack	500 000	0%	500 000
Backyard shack ¹	700 000	17%	580 000
Farmworker household	900 000	15%	765 000
Rural dense	1 150 000	4%	1 105 000
Rural scattered	1 150 000	1%	1 140 000
TOTAL	7 900 000	39%²	4 845 000

Notes

1. Not separately metered.
2. Weighted average.

TABLE 6.1 Access to electricity in 1993 by household type
 Source: EPRET Household Database (1993)

Household type	Initial consumption (kWh/month)	Peak consumption (kWh/month)	Years to reach peak consumption ¹	Connection cost (1993 Rand)
Formal mid-to-high income ²	800	800	n/a	n/a
Formal low income	100	500	7.5	3 000
Informal planned shack	100	500	7.5	3 000
Informal unplanned shack	80	200	4.0	3 000
Backyard shack	80	200	4.0	2 000
Farmworker household	60	150	4.0	3 000
Rural dense	60	150	4.0	5 000
Rural scattered	60	150	4.0	7 000

Notes

1. Based on an annual increase in consumption of 25% until peak level has been reached.
2. All households in this category are already electrified.

TABLE 6.2 Estimated consumption level and connection cost per household category

The consumption levels assumed for the rural households (farmworker, rural dense and rural scattered) must be regarded as rather *conservative*. Hofmeyer (1993) found consumption levels of 200 kWh/month on average for electrified farmworker dwellings analysed in her study. Durban Electricity recorded consumption levels of about 150 kWh/month less than two years after connection of new customers in dense rural areas of Natal. Eskom's recordings, however, are quite similar to the base assumptions used by EPRET. The connection costs assumed for the various household categories are consistent with actual figures experienced by the electricity distribution industry. The only exception might be the rural scattered households where little electrification has taken place so far. A more realistic assumption for this household category might be a gradually increasing connection cost parameter as the household access to electricity in these areas increases over time. The lowest cost and most easily accessible households in this 'high-cost' category will quite naturally be given priority. In practice, it is likely that RAPS (remote area power supply) solutions might be used for some of the connections

in rural scattered areas. For the purpose of the analysis in this chapter, all new connections are assumed to be done by grid-extension.

Other common assumptions used in the EPRET scenarios are:

- Bulk supply cost (Eskom 1992 cost escalated by 8% tariff increase for 1993): 11.19 c/kWh
- Technical distribution losses: 7%
- Capital replacement provision for distribution network (in % of bulk cost): 2%
- Monthly fixed service cost per customer (in 1993 Rand): R20
- National flat-rate tariff for all new domestic customers (excl. VAT): 20.00 c/kWh
- Non-technical distribution losses: 5%
- Real discount rate: 3%

Comments on the level, future development and sensitivity of the above assumptions will be discussed later in the paper. The time horizon for the scenarios is the 17-year period from 1994 up to year 2010.

6.2 Rural electrification in the 'business as usual' scenario

The BAU scenario assumes that electrification will continue at present activity levels for some years and then slow down. Eskom will be the driving force in such a scenario with only limited electrification activity being carried out by the rest of the distribution industry. In this scenario, restructuring of the distribution industry takes a long time and no harmonisation of tariffs and connection fee practices takes place.

The assumed sequencing of the electrification programme in the BAU scenario with regard to the various household categories are presented in Table 6.3.

<i>Household category</i>	<i>Yrs 1-5</i>	<i>Yrs 6-10</i>	<i>Yrs 11-17</i>
Rural farmworker	15	10	5
Rural dense	10	15	15
Rural scattered	5	5	10
Total rural	30	30	30
Formal low-income	50	55	55
Informal planned	15	10	10
Informal unplanned	0	0	0
Backyard shack	5	5	5
Total urban	70	70	70

TABLE 6.3 Percentage of annual connections in each housing category for BAU scenario

For each year of the programme period, 30% of the annual connections are made in rural areas, and 70% in urban areas. In the rural areas, the focus is on the farmworker dwellings, but gradually also on the dense rural settlements.

The assumed overall connection rates and the development of access to electricity in the BAU scenario are presented in Table 6.4 below. As can be seen from the table,

overall access to electricity will increase to 57% by 2000 and to 64% by 2010. The increase in access is gradually slowed down until the annual increase in households is similar to the number of new connections per year.

In the rural areas, access to electricity is assumed to increase more quickly (although from a lower base), and is expected to reach 24% in 2000 and 43% in 2010. The more rapid increase is due to the fact that the number of households in rural areas is expected to remain fairly stable at about 3.2 million. The BAU scenario predicts that about 59% of farmworker households, 44% of households in rural dense areas and 27% of households in rural scattered areas will have access to electricity by 2010. This is based on the assumption that the number of farmworker households are stable at 900 000 while about 150 000 rural scattered households gradually move to dense rural areas.

Year	Annual no. of connections	Overall access to electricity (%)	No. of rural connections	Rural access (%)
1993	300 000	41	30 000	7
1994	300 000	45	90 000	10
1995	300 000	48	90 000	13
1996	300 000	50	90 000	15
1997	250 000	52	75 000	18
1998	250 000	54	75 000	20
1999	250 000	56	75 000	22
2000	200 000	57	60 000	24
2001	200 000	58	60 000	26
2002	200 000	59	60 000	28
2003	200 000	60	60 000	30
2004	200 000	60	60 000	32
2005	200 000	61	60 000	34
2006	200 000	62	60 000	35
2007	200 000	63	60 000	37
2008	200 000	63	60 000	39
2009	200 000	64	60 000	41
2010	200 000	64	60 000	43
Total	4 150 000		1 185 000	

TABLE 6.4 Connection rates and access to electricity in the BAU scenario

The annual cash flow and cumulative financing requirement of the electrification programme in the BAU scenario are presented in Figure 6.1. The annual and cumulative cash flow of the *rural programme* alone are presented in Figure 6.2.

Figure 6.1 shows that the annual cash flow is negative for the entire period of the electrification programme. The accumulated financial requirement by year 2010 will be in the range of R16.5 billion. About R7.0 billion of this relate to the cost of the rural part of the programme as shown by figure 6.2. The figures also show that the major part of the annual negative cash flow relates to the rural part of the electrification programme. *It must be emphasised that these figures are in constant 1993 Rand terms. Hence, the actual future budget requirements will be considerably higher in current prices.*

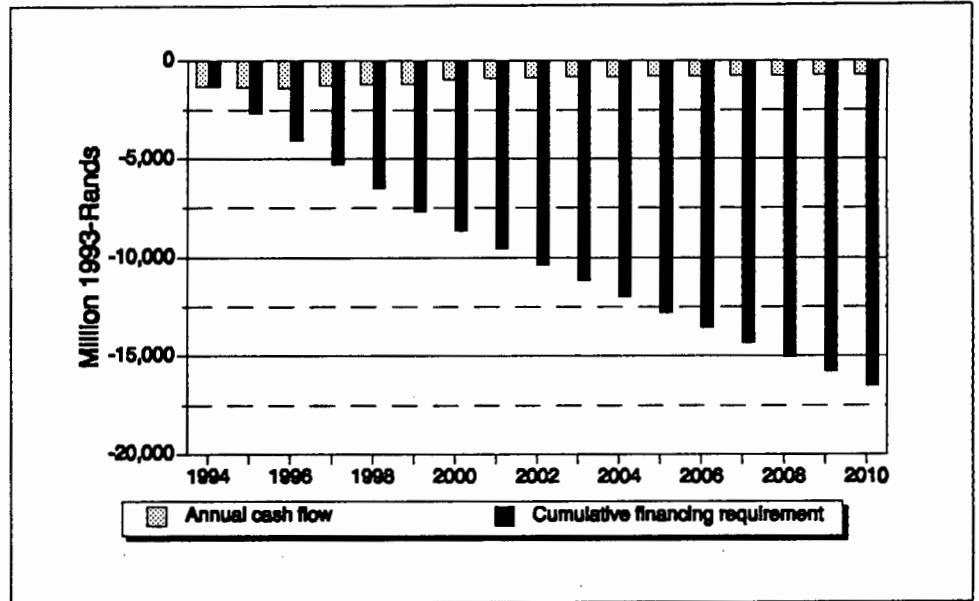


FIGURE 6.1 Annual cash flow and financing requirement – BAU scenario

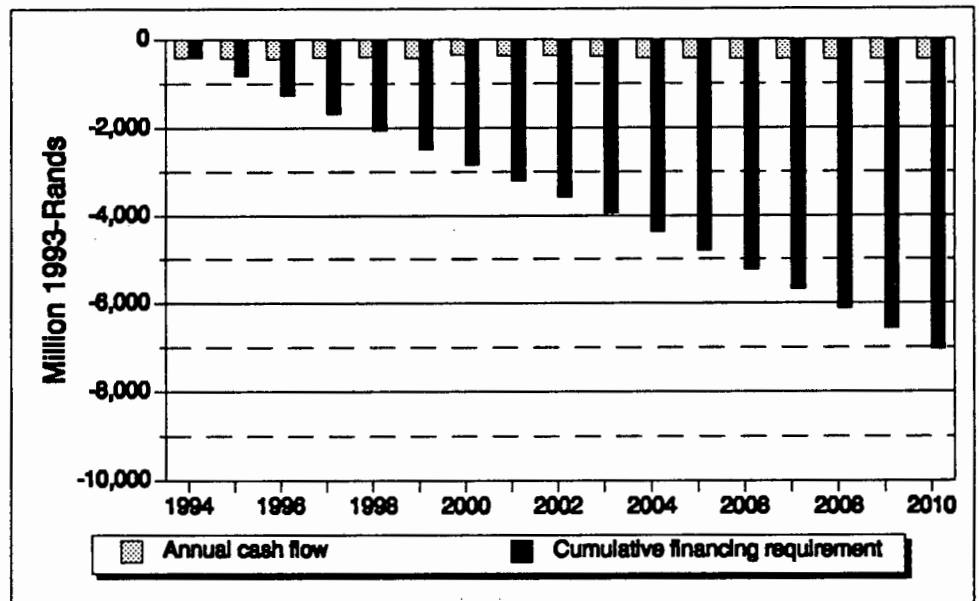


FIGURE 6.2 Rural electrification programme – BAU scenario

6.3 Rural electrification in an 'integrated energy planning' scenario

The IEP scenario assumes that electrification proceeds more rapidly with the help of a restructuring of the distribution industry, harmonisation of domestic tariffs for both existing and new customers and that government financial support for electrification is forthcoming.

The assumed sequencing of the electrification programme in the IEP scenario with regard to the various household categories is presented in Table 6.5 below.

<i>Household category</i>	<i>Yrs 1-5</i>	<i>Yrs 6-10</i>	<i>Yrs 11-17</i>
Rural farmworker	15	10	5
Rural dense	10	10	15
Rural scattered	5	10	10
Total rural	30	30	30
Formal low-income	45	45	45
Informal planned	15	5	5
Informal unplanned	5	10	10
Backyard shack	5	10	10
Total urban	70	70	70

TABLE 6.5 Percentage of annual connections in each housing category for the IEP scenario

As in the BAU scenario, for each year of the programme period, 30% of the connections are in rural areas, and 70% in urban areas. In the rural areas, increased focus is given to electrification of farmworker dwellings for the first five years of the programme.

The assumed overall connection rates and the development of access to electricity in the IEP scenario are presented in Table 6.6 below. Instead of peaking at 300 000 new connections per year, the IEP scenario peaks at 500 000 annual connections in 1996, a level which is kept for six years before the programme is gradually phased down. As can be seen from the table, overall access to electricity will increase to 72% by 2000 and to about 88% by 2010. Also, in this scenario the increase in access gradually slows down as the annual increase in households starts to approach the number of new connections per year.

In the rural areas, access to electricity is assumed to increase quickly and is expected to reach 43% by 2000 and 76% by 2010. The number of households in rural areas is expected to remain stable at about 3.2 million. A comprehensive provision of services (of which electricity is only one type) in rural areas might, however, contribute to counteracting the rural-to-urban migration trend in South Africa. Based on the assumption that the number of rural households remains constant, the IEP scenario predicts that about 90% of farmworker household and about 70% of households in both rural dense and rural scattered areas will have access to electricity by 2010.

Year	Annual no. of connections	Overall access to electricity (%)	No. of rural connections	Rural access (%)
1993	300 000	41	30 000	7
1994	350 000	46	105 000	11
1995	450 000	50	135 000	15
1996	500 000	55	150 000	19
1997	500 000	60	150 000	24
1998	500 000	64	150 000	29
1999	500 000	68	150 000	33
2000	500 000	72	150 000	38
2001	500 000	76	135 000	42
2002	450 000	79	120 000	46
2003	400 000	82	105 000	49
2004	350 000	84	90 000	52
2005	300 000	85	75 000	54
2006	250 000	86	75 000	57
2007	250 000	87	75 000	59
2008	250 000	87	75 000	61
2009	250 000	88	75 000	64
2010	250 000	88	75 000	66
Total	6 600 000		1 185 000	

TABLE 6.6 Connection rates and access to electricity in the IEP scenario

Table 6.6 shows that the total number of new connections in the IEP scenario is about 59% higher than in the BAU scenario, while the number of rural connections is 62% higher. The very strong overall increase in connection rates, particularly in the rural areas, will obviously have considerably financial implications. This is demonstrated in Figure 6.3 below.

Figure 6.3 presents the annual and accumulated financing requirements of the entire electrification programme, using the same tariff assumptions as for the BAU scenario. All figures presented are in fixed 1993 Rand values. The cumulative financial requirement for the programme under this assumption reaches R22.4 billion by 2010, but is still increasing on account of rising operating deficits. Figure 6.4 shows the financial requirement based on the policy assumption that the tariff of already electrified domestic customers is gradually increased from its present average level of about 14.40 c/kWh (excl. VAT) to 20.00 c/kWh (excl. VAT). The tariff of existing customers is assumed to increase by 10% per year until it reaches the level of the new national tariff.

Figure 6.4 clearly demonstrates that, by gradually implementing a uniform national household electricity tariff for both existing and new customers, the *net* peak financing requirement of a major household electrification programme as specified in the IEP scenario, might be reduced considerably – from R22.4 billion to about R9.9 billion. This reduction is due to *cross-subsidies* from existing to new consumers and from high consumption (urban) consumers to low consumption (rural) consumers. By the use of cross-subsidies within the domestic consumer group, the peak financial requirement is reached in 2004. After this point, the annual cash flows start to become positive.

Figure 6.5 shows the annual and accumulated financing requirements of the rural electrification programme in the IEP scenario.

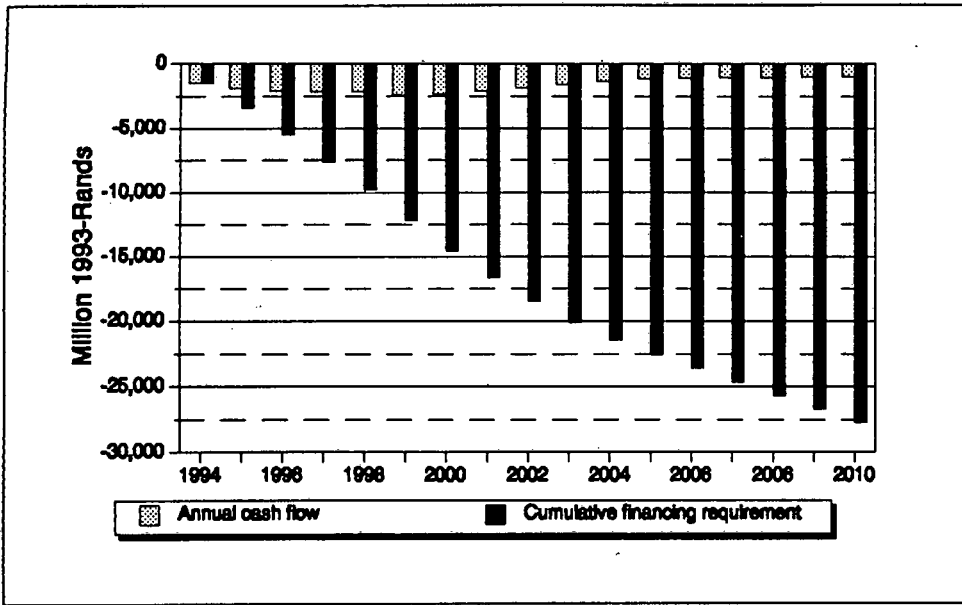


FIGURE 6.3 Financing requirements IEP scenario – no adjustment of existing tariff

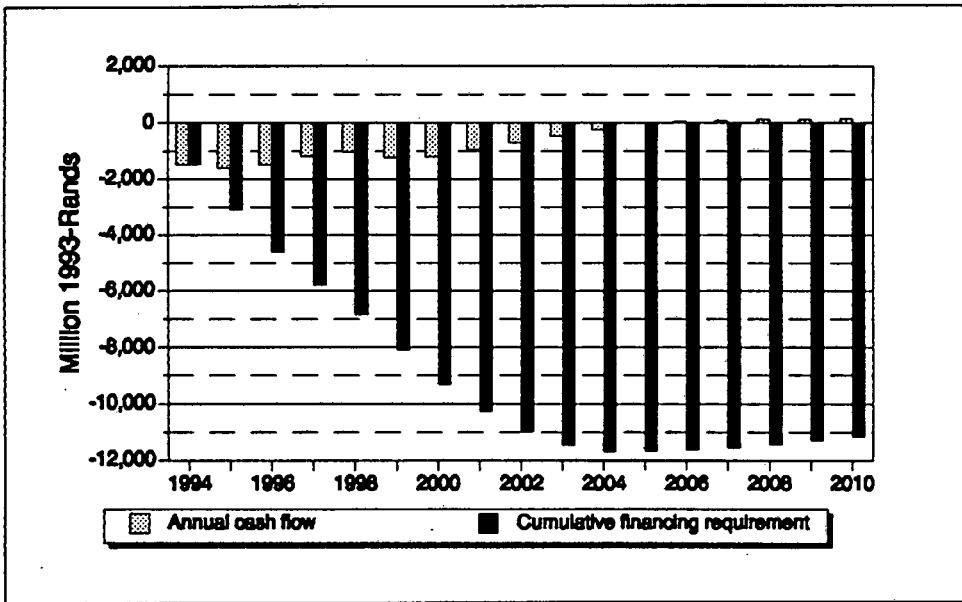


FIGURE 6.4 Financing requirements IEP scenario – gradual adjustment of existing tariff

The figure shows that, in the IEP scenario, the accumulated financing requirement of the rural electrification programme will, by 2010, have reached about R11.7 billion (in constant 1993 Rand). This sum consists of about R3.0 billion for the electrification of 655 000 farmworker dwellings, R4.5 billion for electrification of 720 000 dwellings in dense rural areas and R4.2 billion for electrification of 515 000 dwellings in remote rural areas.

The financial requirements consist of capital expenditure for connection of the rural households and operating deficits due to lower tariff revenues than required to cover supply costs, service costs and capital redemption. This is illustrated in Figure 6.6, where the accumulated financial requirements of the rural programme have been split into cumulative capital expenditure and operating losses. The figure shows that, by 2010, the cumulative capital expenditure will have reached about R11.0 billion while the cumulative operating losses have reached R3.0 billion. It

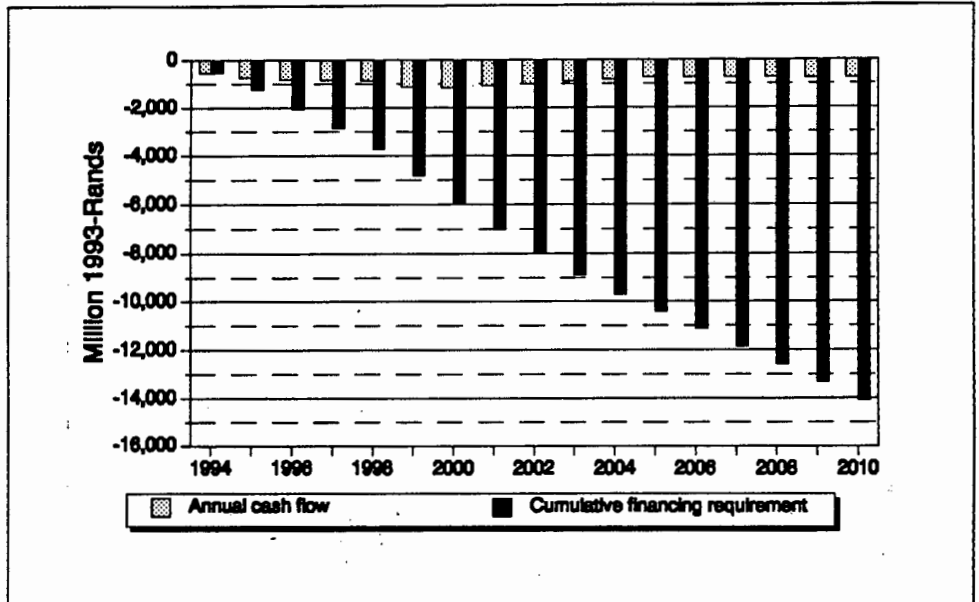


FIGURE 6.5 Rural electrification financing requirements - IEP scenario

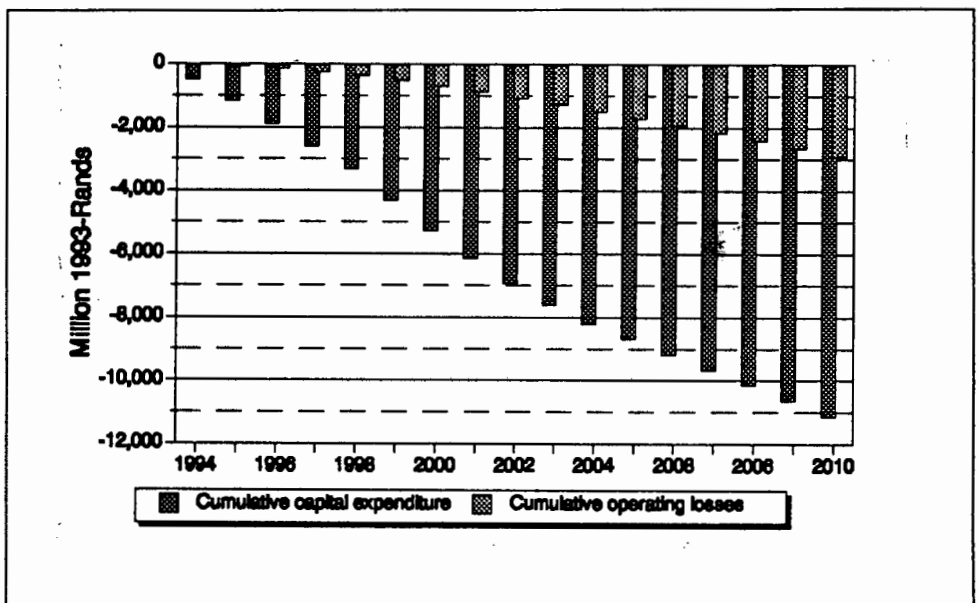


FIGURE 6.6 Cumulative capital expenditure and operating losses for rural electrification

should, however, be noted that operating losses will continue after 2010, even if no more connections are made in the rural areas.

Figure 6.7 shows the annual capital expenditure and annual operating losses for the rural electrification programme.

Annual capital expenditure peaks at almost R0.8 billion in 1999 and 2000 and decreases thereafter to a stable level of about R0.4 billion from 2005. Operating losses increase each year, starting at about R30 million in 1994 and reaching R200 million by the end of the programme period in 2010. The annual operating loss will continue after 2010, because tariff revenues are not sufficient to cover supply and service costs and capital redemption.

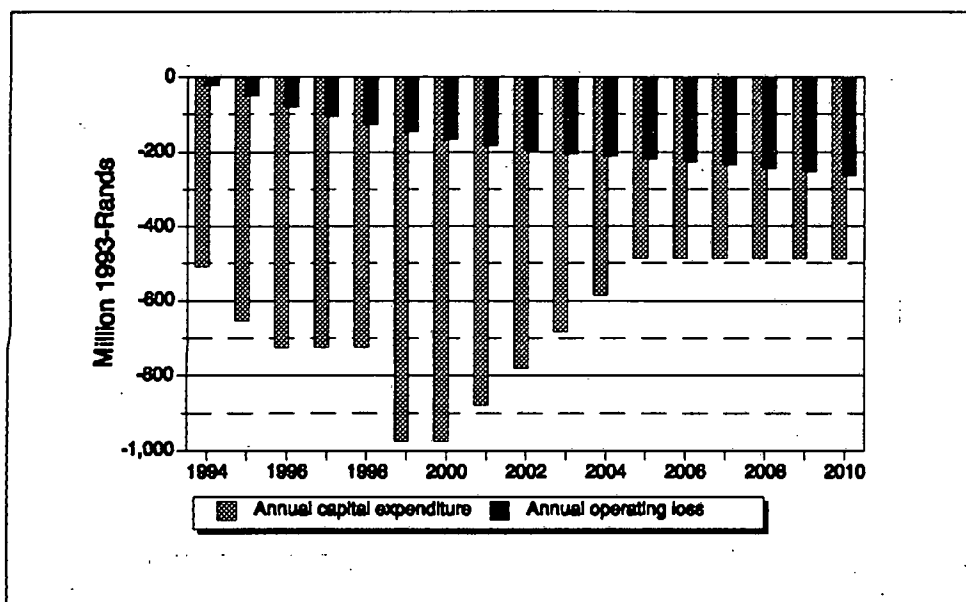


FIGURE 6.7 Annual capital expenditure and operating loss for rural electrification

6.4 Financing options for a major RE programme

Looking at the financing requirement for the electrification programme in the IEP scenario, it is apparent that the urban portion of the programme can be financed through current surpluses generated by urban consumers with high average consumption levels. The major challenge is to manage a rapid restructuring of the EDI in such a way that existing municipal surpluses on electricity generation can be used for electrification of future urban consumers. The other important issue is to gradually increase existing domestic tariffs to the level of the new national tariff.

The situation with regard to a major rural electrification (RE) effort is more uncertain. Cross-subsidies from existing domestic consumers will, for the first 10 to 15 years of an electrification programme, only be sufficient to cover urban electrification. This means that other sources must be accessed to cover the capital expenditure and the expected operating losses on RE. Two sources that should be considered are an *electrification levy* on total electricity generation and a *direct contribution from the government to RE*. Both types of financial contributions should primarily be used to cover connection cost in excess of a national connection cost parameter of for example R3 000 per household. Operating losses should be covered by programmes aimed at increasing availability of electrical appliances to stimulate consumption levels and local contributions to reduce fixed service costs.

A basic principle for undertaking a major RE programme is to maintain the financial viability of the electricity distribution industry. A major element in achieving this will be to measure the industry performance against established national targets for connection costs and fixed monthly service cost per connection. If a connection cost target of R3 000 is set for all connections, urban or rural, the annual required capital expenditure for the IEP RE programme will be reduced by between 40% and 50% on average. The total cumulative industry capital expenditure on new rural connections would be reduced from about R9 billion (constant 1993 Rand) to about R5.7 billion, a reduction of R3.3 billion over the 17-year programme period. This amount of R3.3 billion would need to be raised from sources other than the EDI.

Introduction of an electrification levy on electricity generation in South Africa is one option for financing the excess capital costs of a major RE programme as indicated by the IEP scenario. This would act as a neutral tax on all electricity

consumption and would be easy to administer if levied on the generation of electricity instead of sale. Introduction of a 4% levy on present generation of electricity would raise about R500 million per year. If this levy was imposed for a five-year period, it could contribute about half of the required capital subsidy for the RE programme. The proposed arrangement would take place in the context of Eskom's present five-year price compact with its customers, aimed at achieving a 20% real reduction of tariffs over this period; instead, the reduction would be 16% over the five-year period.

The remaining R2-R2.5 billion required for capital contribution to the RE programme could either come from an extension of the proposed five year period of the electrification levy or by introducing an *extra* government contribution towards RE. The latter would require an annual contribution in the range of R200 million if applied together with an electrification levy as described above.

To summarise: Financing of capital expenditure for a major RE programme appears possible by introducing an electrification levy on electricity generation, possibly combined with a limited extra direct government contribution over the national budget.

6.5 Sensitivity analysis

The above analyses were based on certain specific assumptions for the electrification programme. Critical assumptions should always be checked by sensitivity analysis. The most critical assumptions for the financial viability of a major RE programme are the level of the proposed national straight-line tariff, the future consumption level of rural households, and the supply costs experienced by the distribution industry. The financial analysis of the RE programme has been checked for variations in these key variables.

A 10% change in the level of the proposed national tariff (20 c/kWh) will result in a 7% change in the peak financing requirement of the RE programme. Hence, a 10% increase in the tariff will reduce the total financing requirement by 7% and vice versa. The cumulative operating losses will, however, be reduced by about 33% by a 10% tariff increase. Obviously, the tariff level will impact the operating result and not the capital expenditure requirements.

Changes in bulk supply cost have a similar, but more limited effect. A 10% decrease in supply cost will decrease the peak financial requirement of the programme by about 4%, but will decrease the cumulative operating losses by about 17%.

The assumed maximum monthly consumption level for rural households is another interesting parameter to analyse. The rather conservative base case assumption is that a maximum monthly consumption level of 150 kWh is reached about four years after the initial connection to electricity supply.

If the maximum consumption level was 200 kWh/month for rural households, this would imply that the peak financing requirement would decrease by 4% and the cumulative operating losses would be reduced by about 17%. If the consumption level increased to 250 kWh/month, the reduction in total financing requirement and cumulative operating losses would be 7% and 35% respectively.

All the above parameters affect the operating result of rural electricity supply, but not the capital requirements. If the average connection cost parameters used for the three different types of rural households (farmworkers, rural dense and rural scattered) are reduced by 10%, this will result in about a 10% lower total peak financing requirement, but a 13% lower maximum capital expenditure. The opposite results are observed by increasing the connection cost parameters. Variations in the assumed real discount rate will only change the net present value, *not* the

financing requirement. A value of 3% is accepted as reasonable for such projects.

6.6 Scenarios for RE – concluding remarks

The electrification programme discussed in the IEP scenario was not based on any detailed analysis of actual plans or capacities in the existing electricity distribution industry. It is, however, interesting to compare the programme with whatever plans exist in the industry.

Electrification of farmworker households will mainly become a task for Eskom, as it controls the supply rights in virtually all areas with commercial farmland. As discussed in Chapter 4, it is not clear from Eskom's present plans how it intends to approach a major electrification of worker dwellings. Eskom's present activity in this area indicates an annual number of farmworker connections of between 15 000 and 20 000. This is less than half of what is discussed in the IEP scenario. However, taking into account the rather favourable capital expenditure level of this type of connection, there appear to be possibilities for increasing the present activity in this sector quite rapidly. Consequently, farmworker electrification of a magnitude discussed in the IEP scenario might be achievable if given the necessary priority by Eskom and the new government.

A programme for electrification of predominantly poor households in the 'homeland' areas is much more complicated. The fragmented structure of the EDI, poor local infrastructure, uncertainties about future local government organisation and finances, etc, make electrification in 'homeland' areas a considerable challenge. Furthermore, the actual planning of electrification programmes in these areas is still at a rather rudimentary stage.

Some information about planned new connections has been collected from distribution authorities in most of the 'homeland' areas. This is summarised in Table 6.7.

Area	No. as of 1 Jan 1993	1993	1994	1995	1996	1997	1998	Total new connections
Boph'tswana	57 173	5 000	5 000	5 000	5 000	5 000	5 000	30 000
Ciskei	20 764	0	5 000	10 000	10 000	10 000	15 000	50 000
Gazankulu	9 956	1 150	5 000	5 000	5 000	5 000	5 000	26 150
Kangwane	10 306	4 698	3 400	4 620	5 320	6 122	7 060	31 220
KwaNdebele	11 000	17 000	21 397	15 000	10 000	5 000	4 000	72 397
Lebowa	61 764	9 917	32 740	32 741	32 741	32 740	32 740	173 619
Qwaqwa	15 900	2 000	3 000	3 000	3 000	3 000	3 000	17 000
Transkei	6 671	0	5 000	5 000	20 000	20 000	20 000	60 000
Venda	13 225	1 900	1 900	1 900	1 900	1 900	1 900	11 400
Total	206 759	41 665	82 437	82 261	82 961	88 762	93 700	471 786

TABLE 6.7 Planned new connections in 'homeland' areas for the period 1993-98
Source: Information from Eskom and 'homeland' authorities as of September 1993

Compared to the number of new connections proposed in the IEP scenario, the above total connection rates appear quite reasonable. It is proposed that about 470 000 new connections will be made in the nine 'homeland' areas included in the table over the six-year period 1993-98. This number excludes connections to be made in KwaZulu (by local authorities, Eskom and Durban Electricity). At least half of the connections in the 'homeland' areas will be made in rural areas. Including KwaZulu, that should indicate that somewhere between 250 000 and 300 000 new rural connections are planned in the 'homeland' areas for the period up to 1998.

This is close to the assumed number of rural connections in the IEP scenario for the same period (excluding connection of farmworker dwellings) of about 345 000, a promising outlook, if the 'homeland' authorities could manage to comply with their plans.

There is, however, good reason to question the number of new connections planned in some of the 'homeland' areas. The plans for Bophuthatswana, Gazankulu, KaNgwane, Qwaqwa and Venda appear realistic, while the plans presented by Ciskei, KwaNdebele, Lebowa and Transkei appear unrealistically high, taking into account the present situation of electricity distribution in these 'homeland' areas. Hence, the future for a major electrification programme for rural households in 'homeland' areas seems very uncertain, due to problems related to local government structures and the required restructuring of the EDI.

Having analysed the financial implications of a major RE programme as set out in the IEP scenario, it is obvious that the costs of a programme aimed at providing electricity to about 66% of the rural population by 2010 will be very high. It has, on the other hand, been demonstrated that the programme can be financed by a combination of cross-subsidies from other consumer groups, the introduction of an electrification levy on generation, and a limited extra direct government contribution over the national budget.

Investing R9 billion in providing access to electricity in rural areas and covering another R2.7 billion in operating losses – a total financial obligation of about R11.7 billion (in 1993 prices) – must, however, be carefully weighed against other high-priority needs of the rural households and alternative use of resources for rural development.

The analyses in this chapter have focused only on the financial implications of a major RE programme. Even if a major RE programme is not directly financially viable, it might be a worthwhile undertaking when evaluated in a socio-economic context. It has not been possible to include a cost-benefit analysis of the RE programme in this paper, but such an analysis should be carried out as a priority task.

Conclusions and recommendations

7.1 Conclusions

Introduction of electricity into a rural society will not in itself induce economic change and incomes sufficient enough to pay the actual cost of the initial years of electricity consumption. Therefore there would be a need to cover some of the costs through subsidies to allow rural households access to electricity. In order to minimise such subsidies, there is a need to identify other loads than those of households – of, for example, schools, clinics, and community centres. Subsidies, however, can also be justified on grounds of improved equity, social well-being, and development potential. Careful government planning must not optimise such subsidies at the expense of other vital rural development projects.

Following the principle of integrated energy planning, other supply options of household energy in addition to electricity, need consideration, from the perspective of households' end-use requirements. It should be recognised that cross-subsidies from non-rural to rural households, as well as from non-household consumers, would be crucial.

In order to implement successfully a considerable rural electrification (RE) programme, the electricity supply industry must sustain itself financially and, in doing so, give due consideration to fundamental principles such as: the establishment of a national straight-line household tariff, national connection cost parameters, a national service cost parameter, and adhering to the principle of least-cost supply options.

At the micro-level, the RE programme must be planned in cooperation with the people it shall serve.

The present picture of RE in South Africa is complicated and fragmented. It is still in its infancy, with Eskom gradually becoming the most important distributor in rural areas, including the 'homelands'.

Electrification of rural centres and dense village-type settlements appears to be the trend among those distributors with an RE programme of any significant size, including electrification of local community facilities and small-scale commercial enterprises where such exist. Farmworker households on commercial farm land in RSA, on the other hand, do not appear to be a major target in Eskom's electrification programme, although it is likely that this household category can be electrified within acceptable cost ranges and with the active support of the farmer community.

Important problem areas are the widely differing practices with regard to connection policies and connection fees charged to customers, tariffs charged for rural electricity supply and government policy for subsidising electrification. The latter is particularly related to the situation in some 'homeland' areas where government subsidy of the energy tariff is common. This is, in fact, an inequitable consumption subsidy benefitting existing consumers more than subsidising new consumers' access to electricity.

The current structure of the electricity distribution industry in rural areas is an obstacle to a rapid and large-scale RE effort, particularly in former 'homeland' areas, although with some exceptions. It is quite clear that a major restructuring of the electricity distribution industry in homeland areas will take time, both because Eskom needs time to assimilate the former 'homeland' distributors within its own organisation and because considerable unresolved problems persist with regard to

future local government organisation and responsibilities.

The time horizon for a major South African RE programme will be at least 15-20 years, with initial priority being given to support development of rural growth-points (both local public service provision and households) as well as electrification of farmworker households.

Access to electricity (connections) should be subsidised, not the use of electricity.

Restrictions should be placed on maximum allowed cost per connection, but there should be opportunity for local communities to negotiate contributions or different levels of supply service in order to gain access to electricity.

While the electricity distribution industry gets restructured, efficient local distributors and Eskom should be allowed to go into areas (through negotiated take-overs or cooperative arrangements) where they have no formal supply rights.

The government must, through a specific budget line item, commit and sustain reasonable subsidies (capital transfers) to the utility under a contract plan arrangement. It has been estimated (Chapter 6.4) that an annual government capital subsidy of about R300 million (at 1993 prices) would be required for the duration of the RE programme (1994-2010).

7.2 Policy recommendations

Based on financial analysis of RE scenarios for South Africa, the following recommendations are proposed for implementation at the policy level, to foster a sustainable development of RE in the new South Africa:

1. RE should be viewed as an integral part of a comprehensive, broadly-based, long-term national policy for rural development in South Africa, consistent with current and expected future budgetary constraints. Rural development policies must be based on genuine local needs and local participation in planning and implementing the various programmes.
2. An appropriate electricity industry legislation and regulatory framework must be put in place to facilitate national electrification efforts, both in urban and rural areas. While the electricity industry itself might be able to handle the challenges of future electrification of urban areas, the government has a special role in fostering more equitable access to electricity in rural areas. The government might wish to introduce a form of taxation (electrification levy), for instance in the form of a specific levy on electricity generation, in order to facilitate the redistribution of the sector's financial surpluses to assist in financing rural households' access to electricity.
3. A national electrification policy and programme must be designed with a balance between electrification of urban and rural areas from the outset, in order to address the need for redistribution, and the material needs of the poorest households. Striking a balance between rural and urban electrification will also contribute to diversification of the risks (political and commercial) inherent in a major household electrification programme. The quality and service level for electricity provision in rural areas should be carefully weighed against the electricity needs of the rural population within the framework of integrated energy planning.
4. The government, represented by all ministries involved in rural development, together with the electricity distribution industry, should develop a national RE policy, programme and action plan. The plan should have a defined long-term time horizon and contain information about financial and other commitments to the rural development programmes of each of the

parties involved. The action plan must be based on a clear understanding of how to rank and prioritise RE projects, and have monitorable targets as to how many, where, and at what cost, RE should be carried out.

5. Government policy, programmes and plans must be based on the principle of a least-cost electricity supply solution, including both grid and non-grid developments of electricity provision in rural areas.
6. The national RE programme should not be in conflict with the principle of maintaining a financial viable electricity distribution industry in South Africa. Hence, a capital contribution per connection in rural areas shall be provided by the government to the industry to cover connection costs above a certain national level. It is recommended that the government, for each year of the programme period, allocates a specific amount as a line item on its annual budgets to support of RE.
7. The tariff charged for electricity in rural areas should be equal to a national (possibly at a later stage regional) household electricity tariff (set to meet the requirement of a financially viable industry), based on the principle of a straight-line tariff, implying a cross-subsidy from domestic consumers with higher average consumption levels to consumers in rural areas.
8. The RE programme must, from the outset, aim at electrification of a number of rural 'growth centres' (including electrification of both local community facilities and households), with an identified socio-economic potential and possibilities for establishing productive activities.
9. The national RE programme must from the start also pay serious attention to electrification of rural dense and rural scattered households, in particular rural dense ones, in addition to farmworker households on commercial farms.

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PROJECT DESCRIPTION

A major two year research project was launched by the Energy for Development Research Centre in April 1992. It aims to investigate policy options for widening access to basic energy services for the urban and rural poor in South Africa. Research papers are being produced in the following areas:

Background papers

Research outline

Integrated energy planning: a methodology for policy analysis and research

Development context for energy planning in South Africa

Background on South African energy system

Energy demand analysis

Energy demand in underdeveloped urban and rural areas

Rural areas

Energy for rural development: an introduction and overview

Energy and small-scale agriculture

Rural household energy supply options

Afforestation and woodland management

Remote area power generation options

Urban areas

Household energy supply in formal and informal urban settlements

Energy and informal sector production

Ancillary sector

Energy and mass transportation*

Key supply sector

Electricity distribution sector*

Cross-sectorial studies

Energy efficiency and conservation*

Energy and environment*

Southern Africa linkages*

Investment requirements and financing mechanisms*

Pricing policy*

Institutional analysis*

Policy options

A concluding document will draw together key policy conclusions

** The scope of these studies is restricted to energy issues concerning the urban and rural poor.*

EDRC

The Energy for Development Research Centre is located at the University of Cape Town. Its objectives are to study energy related problems of developing areas in Southern Africa, and possible ways to address them.

EDRC seeks to achieve its objectives by:

- undertaking research projects;
- running a specialist postgraduate programme to support research projects and to train personnel to contribute to this field;
- transferring relevant information to user groups by offering consulting services and running workshops, and through publishing books, journal papers, reports, leaflets and design and user manuals.

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