Criteria for integrated grid and off-grid electrification planning: Summary paper

D I BANKS
C THOM

1998
ENERGY & DEVELOPMENT RESEARCH CENTRE
University of Cape Town

Contents

Acknowledgements

We would like to acknowledge the important inputs to this project provided by staff of the Development Bank of Southern Africa, Eskom, the Independent Development Trust, the National Electricity Regulator, the Department of Minerals and Energy, the former Refsa and the Associated Municipal Electricity Undertakings. Key individuals involved in electrification decision-making gave of their time and experience in discussions, both at the project workshops, and in follow up meetings conducted on an individual basis. EDRC colleagues acted as attentive and stimulating soundboards. Paul Galen (NREL) and Hilton Trollip, authors of parallel papers on related issues helped us to wrestle with the complex issues, and provided valuable input.

The work was supported financially by the DBSA and by joint funders of the three-year EDRC project 'The role of electricity in the integrated provision of energy to rural areas' (Department of Minerals and Energy, Eskom TRI and NORAD).

Preface

The focus of this paper is on the development of criteria to support electrification decision-making. Criteria for both strategic resource allocation (as required in sharing out a national resource between different provinces) and operational decision making were reviewed by the research team. Recommendations are made regarding suggested best practice, in the context of an emerging electrification policy and strategy framework. Off-grid electrification is becoming an important component of rural electrification in South Africa. This is explicitly included in the analysis and development of operational level criteria, as this was identified as the most appropriate locus for technology specific decision-making.

This document is brief and not referenced. For further information on current practice, the recommended criteria developed, and for information regarding reference material and discussions held, the reader is referred to Thom (1998) and Banks (1998).

1. Criteria for the allocation of grant funding to the provinces

One of the important issues in electrification policy is the allocation of financial resources available for electrification at a national level to smaller entities such as provinces, local authorities, and/or regional electricity distributors (REDs). This part of the paper discusses the allocation of grant funding available to the provinces in South Africa for the electrification of poor and historically neglected areas and communities. The focus is on allocation principles and criteria, but the process by which allocation takes place is also discussed, as it was found that these aspects cannot be divorced altogether.

It is not yet clear whether grant funding available for electrification at a national level will be primarily allocated to REDs, operational entities within a single national distributor, and/or local authorities. This depends on the outcome of the restructuring of the electricity distribution industry. Nevertheless, whatever the nature of the actual funding streams, government will need to guide the allocation of available resources to the different provinces. This is important for planning purposes, as the provincial governments are responsible for planning and co-ordinating a range of development sectors. It is equally important from a political perspective.

The allocation of public resources is a political function, and the provinces are important political entities in South Africa. In the absence of government policy on this matter, political processes have already impacted significantly on the allocation of electrification resources to the provinces. Eskom in particular has experienced increasing pressure from political lobby groups in recent years regarding the allocation of resources to the provinces as well as to particular areas within provinces. Government policy therefore needs to set guidelines as well as criteria for the allocation of grant funding for electrification to the provinces. It is hoped that this paper will contribute to the development of policy in this regard.

1.1 Criteria currently used

The three national bodies involved in the funding of household electrification – Eskom, the National Electricity Regulator (NER), and the Development Bank of Southern Africa (DBSA) – all have some way of allocating resources to different provinces.

1.1.1 DBSA

The DBSA has developed an index to guide the allocation of its resources to the different provinces for infrastructure lending, particularly for water, sanitation, electricity and road projects. Concessionary loans have been provided to Eskom and local authorities for electrification projects. Each application has been evaluated according to a range of criteria.

The two key criteria comprising the DBSA allocation index are the poverty and economic potential of provinces. The 'poverty gap' or 'the amount of money needed to adjust the income of families below the poverty line, to above or on that line' is used as a measure of the poverty of the provinces. The real GGP of a province is used as a measure of its economic potential. The composite allocation index used by the DBSA was obtained by taking the average of the 'Poverty' and 'Economic potential' indices, thereby effectively giving equal weight to each of the key criteria.

The composite index was clearly established with the intention of capturing the divergent needs the DBSA aims to address in a single entity. However, combining two indices that reflect very different and, in fact, opposing objectives in a single composite index is not a satisfactory way of doing this. The combined index does not have any real meaning, in spite of the fact that each of the indices separately represents a very specific objective.

1.1.2 NER

The NER is responsible for the allocation of the R300 million grant from Eskom to the local authorities for electrification. The funds are allocated in response to applications received from local authorities, which are evaluated according to a range of criteria. As with the DBSA, an allocation index was developed to guide the allocation of funds to the different provinces, based on a limited number of key criteria. The NER also does not allocate specific amounts to the different provinces. The NER identified three criteria that can be used to guide the allocation of electrification subsidies to the provinces. These are:

- the 'total need for electrification' in the provinces, measured in terms of the numbers of unelectrified houses in the provinces;
- the 'need for electrification in urban areas', which is measured in terms of the numbers of unelectrified houses in 'urban' areas in the provinces;
- the 'demand for electrification in urban areas', measured in terms of the numbers of electricity connections for which funding applications were received from local authority distributors in the provinces.

A composite allocation index was obtained by taking the average of the 'Urban needs' index, the 'Urban demand' index, and the composite DBSA index, thereby giving equal weight to each of them. Combining the 'Urban need' and 'Urban demand' indices does not seem problematic, as they capture similar considerations. A composite index comprising these two indices would therefore be internally consistent. However, combining these indices with the composite DBSA index seems inappropriate in light of the concerns raised about the DBSA index.

1.1.3 Eskom

The main allocation criteria that were used by Eskom to plan for 1998 are the following:

- The numbers of potential connections – that is, unelectrified houses within areas where Eskom has supply rights, that could be electrified at an acceptable cost due to the proximity of the grid – in Eskom's engineering (or planning) areas.
- The projected average cost per connection in each engineering area.
- Political demand for electrification in the provinces.
- The numbers of unelectrified houses in the provinces.
- The electrification plans of other major utilities in the provinces.

These criteria were not quantified and weighted, and then used to calculate an index which sets the allocations to the different provinces, as done by the DBSA and NER. Rather, the criteria seemed to be applied during the allocation process followed by Eskom.

The allocation process primarily involves the national Electrification Planning office, Electrification staff in the engineering areas, and network planners in the Distribution Technology division. The final allocations to engineering areas and provinces are reached through interaction among the different groups in Eskom involved in the allocation process. While potential connections and projected connection costs seem to 'drive' the allocation process, the outcome of the allocation process also seems to be 'pulled' in a certain direction by political considerations. For example, resources have been allocated to agree as closely as possible with the percentage of all unelectrified houses in the country found in each of the provinces, within the constraints faced by Eskom. The main exception to this has been KwaZulu-Natal, where the large electrification programme conducted by Durban Metro Electricity has meant that Eskom's programme in the province has been reduced accordingly.

1.1.4 Conclusions

The following conclusions have been drawn from the analysis of criteria currently used by electrification agencies in South Africa:

1. There seems to be broad agreement that it is best to use a small number of key criteria that are simple and clear, to ensure that all concerned parties can understand the basis for the allocations to provinces. The organisations discussed here all used a fairly small number of key criteria for the allocation of resources to provinces – the DBSA used two, the NER three (four if the two DBSA criteria are considered separately), and Eskom used five.
2. It is essential that the allocation of resources be done through a process during which all the important criteria are carefully considered. It can take the form of a planning process (as in Eskom's case) during which different criteria are considered at different stages of the process. Or it can take the form of a process of evaluating actual funding applications, as in the case of the DBSA and NER. Human judgement needs to play an important role in the allocation process.
3. It is helpful to establish an index for each of the key allocation criteria if at all possible, as indices can guide the allocation of resources very effectively. However, not all the important criteria can necessarily be quantified and therefore captured in indices. Some criteria may have to be considered without the aid of an index, as is done by the DBSA and NER when assessing actual funding applications.
4. Individual indices can be combined to form a composite allocation index. However, indices that reflect opposing objectives or considerations (such as the need for poverty alleviation, and the need to support economic growth; or the need to minimise costs, and the need to address inequalities) should not be combined in a single composite allocation index. They should rather be weighed up against one another in the allocation process, applying human judgement to make the final allocations.

1.2 Analysis of possible criteria for provincial allocations

The social and economic objectives of the electrification programme have not been clearly defined as yet. Nevertheless, the DBSA index with its dual nature seems to reflect quite well what many people regard as the goals of the programme – on the one hand, addressing poverty, and, on the other, supporting economic development. Certainly the most challenging aspect of the allocation of electrification funding to different entities is making provision for both of these largely opposing imperatives, particularly considering the extreme inequalities that exist in our society and economy. For the purpose of this discussion a distinction is made between criteria that support 'economic growth' on the one hand, and those that support 'socio-economic development' on the other.

1.2.1 Criteria that support economic growth

The following criteria could be used to allocate grant funding for electrification to the provinces in order to support economic growth.

1.2.1.1 The contribution of provinces to the national economy

This criterion is measured in terms of the gross geographic product (GGP). However, the GGP provides no indication of the extent to which provinces require electrification *subsidies* for projects that will contribute to economic growth. For example, while Gauteng would be strongly favoured by an allocation index based on GGP, analysis has shown that the province generated more than half of the total surplus in the distribution industry and would be a net contributor to a National Electrification Fund. It is therefore less likely to require electrification subsidies than most of the other provinces. This index therefore does not seem particularly suitable as a criterion for the allocation of grant funding for electrification to the provinces.

1.2.1.2 The macro-economic impact of electrification undertaken in the provinces
Electrification funds would be allocated to the provinces to maximise the impact of electrification on the national economy as far as possible. For this purpose a macro-economic analysis of the electrification programme would have to be done, including an investigation of the effects of varying the rate of electrification in the different provinces. This should probably consider the effects of appliance acquisition, income substitution, and capital investment on the national economy, including the effects on GDP, job creation, capital requirement and the national balance of payments. It is not clear, however, whether this criterion can be assessed and quantified in a meaningful way.

1.2.1.3 Electrification projects contributing to economic growth
This criterion offers a direct way to assess the degree to which each province requires grant funding for electrification projects that contribute to economic growth. The suggested approach is to allocate funds to the provinces on the basis of planned electrification projects in poor and historically neglected areas that are expected to contribute significantly to economic growth. These may include the electrification of certain residential areas – for example, some townships and informal settlements in metropolitan and major urban areas. Electrification projects that form part of broader initiatives to achieve economic growth in poor and historically neglected areas, such as spatial development initiatives (SDIs) and small-farmer agricultural projects, could also qualify for grant funding on this basis.

Criteria would need to be established to select the projects that will be supported. These could include the economic and financial net present value (NPV) of the electrification projects, and projected growth in local production and job opportunities. It is envisaged that the funding allocated to one of these projects would comprise the shortfall between commercial finance and other funding sources, such as a concessionary loan, on the one hand and the total costs of the project on the other.

The number of electrification projects that would qualify for funding based on this criterion in any particular year is expected to be relatively small. It should therefore be possible to process funding applications at a national level. If this were not the case, it would make the application of this criterion very difficult, if not impossible.

1.2.2 Criteria that support socio-economic development

The majority of electrification projects are undertaken in residential areas where major spin-offs in terms of economic production are unlikely, although this does not mean that the contribution of electrification to these areas is insignificant. Realising the potential benefits of electricity is dependent on a wide range of factors, however, including the effective education and involvement of local people, as well as effective co-ordination between electrification and the health, education, water supply and other sectors.

An attempt has been made to identify criteria which would ensure that electrification supported socio-economic development most effectively.

1.2.2.1 Number of unelectrified facilities providing services in the different provinces
The provision of social services such as education, health and water supply is an important aspect of socio-economic development. While the extent to which households benefit from electricity depends largely on their wealth or poverty, all households can potentially benefit from improvements in service provision. It is therefore necessary to ensure that the allocation of electrification subsidies to the provinces reflects the importance of social services. Details such as the facilities that would be included, and whether all these facilities would be given the same weight, would have to be established at some stage.

1.2.2.2 Complementary development initiatives in the provinces
The impact of electrification on its own is fairly limited. There are a variety of initiatives that would complement an electrification programme and thus enhance the impact of the

programme by developing human and organisational ability, assisting people in providing for themselves, and providing basic infrastructure in impoverished areas. The extent to which such programmes are underway and are shown to be effective in the different provinces would be an important criterion for the allocation of electrification subsidies, even though it would not be possible to quantify it. The criterion could only be applied in a meaningful way, however, if reliable information on the key programmes in the provinces is available.

1.2.2.3 Economic assessments of electrification projects

As household electrification forms an important part of an electrification programme, it is desirable to capture household-level benefits in a criterion for the allocation of subsidies to provinces, in addition to the criterion on social infrastructure already discussed.

One possible criterion is the average economic net present value (NPV) per electricity connection that is expected for electrification projects in each of the provinces. In order to establish this, a national study would have to be undertaken to do economic assessments of electrification projects in each of the provinces, which would clearly be a major undertaking. This approach would, however, be time-consuming and highly costly to apply.

1.2.2.4 Targeting different socio-economic groups

Another option that was considered in order to define a criterion based on socio-economic benefits at a household level was to give greater priority to certain socio-economic groups in the electrification programme. One possibility is to give most weight to one particular group; for example:

- communities in *metropolitan and other areas* where significant economic growth is experienced (even though the electrification projects themselves do not contribute significantly to economic growth), and where people are therefore likely to benefit most from electricity;
- the most impoverished areas which are in greatest need of development (that is, applying the principle of social equity), and would certainly benefit from access to electricity, although not as much as the first group; or
- the intermediate group that does not fall in either of the other two categories, which probably comprises the majority of poor and historically neglected communities.

Another possibility is to treat every province separately, and to allocate most weight to the group with least access to electricity, and least weight to the group with greatest access to electricity in each of the provinces. The weights would therefore probably differ from province to province. This would promote greater *social equality* in access to electricity among different socio-economic groups in each of the provinces.

Considerable analysis would be required to develop and apply a criterion based on this approach. Furthermore, as the impact of electrification on different households in the same socio-economic group can differ substantially due to a range of factors, it would be very difficult and possibly unwise to generalise to this extent. Nevertheless, this seems to be the only real option for establishing a criterion that reflects the fact that the socio-economic impact of electrification on households and communities can differ substantially.

1.2.2.5 Poverty levels in the provinces

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

1.2.2.6 Numbers of unelectrified houses in the provinces

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

1.2.3 Other important considerations

In addition to the social and economic objectives of the electrification programme, there are some financial and political considerations that need to be included in the allocation process as far as possible.

1.2.3.1 Average connection costs in the provinces

The average cost per connection varies considerably between the provinces. The reasons for particularly high connection costs in some of the provinces range from scattered settlement patterns in traditional areas and the topography of the areas (KwaZulu-Natal), to the need for network expansion to electrify 'black' residential areas in small towns (Free State), and the absence of a network of electricity lines serving commercial farms (Transkei). In order to treat all provinces in an equal manner, the actual costs of extending the grid, whether due to historical or geographical factors or both, need to be factored into the allocation of funds to the different provinces as far as possible.

1.2.3.2 Political demand for electrification

Local councillors responsible for 'rural' areas may want to continue to provide input to the provincial allocation process even when a national policy has been established. It seems unlikely that local politicians will simply accept allocations made according to national policy – each level of government have particular issues that concern them, and service delivery is of particular concern to local government. Eskom's experience in this regard suggests that local politicians want the assurance that their province is receiving its fair share of the available resources to address the inequalities in access to electricity that exist between the provinces. The numbers of unelectrified houses in the provinces, as captured in the 'Total needs' index defined by the NER, seem to have been regarded as a fair allocation criterion from this perspective.

1.3 Conclusions and recommendations

1.3.1 Provincial allocation criteria

The social and economic allocation criteria discussed above are assessed in Table 1 using the following criteria:

- Is the criterion appropriate for the allocation of grant funding for electrification to the provinces?
- How much work would be required to develop the suggested approach and define the criterion clearly if necessary, and/or to establish an index where possible?
- Is the criterion easy to understand conceptually?
- Is the criterion easy to apply – for example, would an index be available, and to what extent would the criterion be captured effectively by the index?

The assessments attempt to reflect the discussions on the various criteria as far as possible.

Table 1: Assessment of possible allocation criteria

Criteria	*Appropriate for its intended purpose?*	*Is work needed to develop the criterion / an index?*	*Easy to understand?*	*Easy to apply?*
Economic growth criteria				
Contribution to national economy	Only partly	Very little	Yes	Yes
Macro-economic impact	Only partly	Yes	Fairly	Fairly
Projects linked to economic growth	Yes	Yes	Yes	Depend on no. and type of applications
Socio-economic development criteria				
Unelectrified social infrastructure	Yes, with some reservations	Yes, if more than schools and clinics are included	Yes	Yes
Complementary development initiatives	Yes	Yes	Fairly	No, very difficult
Project economic assessments	Only partly	Yes, probably an unrealistic undertaking	No	Fairly
Targeting socio-economic groups	Yes, with some reservations	Yes	Fairly	Fairly
Poverty levels	Only partly	Very little	Yes	Yes
Unelectrified houses	Only partly	Very little	Yes	Yes

Based on these considerations, the preferred economic growth criterion is 'Electrification projects that contribute to economic growth'. If this proved too difficult to apply – for example, if the number of applications received makes it impossible to conduct this selection at a national level – another criterion would have to be developed. Although 'Contribution to the national economy' seems the best alternative, it is not satisfactory because of the complete dominance of Gauteng in the index. The criterion 'Macro-economic impact of electrification' cannot be recommended, as this would need to be developed further, and it is not clear whether this would offer a meaningful way to allocate the resources.

It is recommended that the criterion 'Unelectrified social infrastructure' be used for socio-economic purposes, preferably with a wider range of facilities than schools and clinics only. At least one of the other socio-economic criteria should be used in conjunction with this, preferably one which captures the socio-economic benefits at a household level. As 'Economic assessments of electrification projects' would require extensive analysis without necessarily resulting in a satisfactory criterion, this should not be considered. It is recommended that 'Targeting socio-economic groups' be investigated further with the aim to define a clear criterion that can be used for allocation purposes. In spite of the shortcomings of this criterion, it seems to be the only real option for establishing a criterion that reflects the fact that the socio-economic impact of electrification on households and communities can differ substantially. If this option cannot be developed further, or proves unsatisfactory, either one of 'Poverty levels' and 'Numbers of unelectrified houses' could be used as the second socio-economic criterion. Seeing that there seems to be a correlation between these indices, using the average could also be considered.

The criterion 'Complementary development initiatives' is an important one, as it draws attention to the importance of other development initiatives in creating the conditions that would enhance the impact of electrification. It is recommended that this criterion be investigated further with the intention of focusing it more – for example, identifying a few specific initiatives that could be used to assess the provinces, as well as some criteria that could be used to assess the success of these initiatives.

1.3.2 The provincial allocation process

The process recommended for the allocation of grant funding for electrification to the provinces, using the preferred criteria, is outlined here. Two alternative processes that could be used if the recommended criteria are not accepted are also outlined in the original paper (Thom 1998).

1. Apply the criterion 'Electrification projects that contribute to economic growth' without establishing an index. That is, allocate funds to actual electrification projects that will contribute to economic growth in poor and historically neglected areas and communities, and will be implemented in the year under consideration. This establishes the total amount that will be used to support economic growth in the provinces in that year, while the rest of the funds can be used to support socio-economic development.
2. Establish indices for the criteria 'Unelectrified social infrastructure' and 'Targeting socio-economic groups'. Calculate a *composite index for socio-economic development* by taking the average of these two indices, thereby giving equal weight to the electrification of households and the electrification of social infrastructure.
3. Apply the criterion 'Complementary development initiatives' by modifying the composite socio-economic index somewhat to reward provinces where the selected complementary initiatives exist and are successful, and penalise those where very little exists and very little is achieved. An index should not be established for this criterion, as it would not be meaningful. Human judgement would have to be applied.
4. Modify the socio-economic index once more to compensate provinces where the highest average connection costs are experienced as far as possible.
5. Use this modified socio-economic index to allocate the funds available to support socio-economic development in the provinces (at the end of step 1). This establishes the full allocations to each of the provinces for a particular year.
6. The political acceptability of these allocations could be assessed by comparing it with allocations based on the criterion 'Numbers of unelectrified houses' in the provinces (the 'Total need' index of the NER), which can be seen as a measure of political demand at a provincial level.

1.3.3 Criteria for allocations to planning areas

The project selection and prioritisation processes discussed below are undertaken within planning areas that are considerably smaller than the provinces. Most of the *recommended* and some of the alternative criteria discussed above can be used to allocate grant funding to such planning areas. These are:

- electrification projects that contribute to economic growth;
- unelectrified social infrastructure;
- complementary development initiatives;
- numbers of unelectrified houses;
- average connection costs;
- political demand for electrification.

2. Operational level criteria

2.1 Electrification planning framework

Operational-level planning is assumed to take place within a larger electrification resource allocation framework. The principal stages are:

- A national level identification of programme priorities and objectives, with definition of a multiyear programme budget.
- Allocation of resources to provinces according to the allocation criteria discussed above.
- Allocation of resources to sub-regional planning areas, using similar criteria to those for the provincial allocation.
- Sub-regional project identification and technology selection.

The level at which discussion in this section focuses is on the sub-regional (operational) level planning. The key questions for which criteria are required are:

- Which settlements in a region should be electrified using the grid?
- Which settlements in a region should be electrified using off-grid technology?
- How should electrification projects be prioritised relative to each other?
- What conditions should either grid or off-grid projects satisfy before actual project implementation can be approved?

The approach and rationale for the recommended criteria is briefly discussed below. The recommended criteria are listed in the Appendix.

2.2 Costs and benefits of electrification options

Prior to exploring criteria used for project level electrification decision-making, it is important to briefly review the both grid and off-grid electrification, highlighting the differences in service offered, and costs involved.

Electrification activity in South Africa is strongly dominated by the grid electrification programme, with current activity taking place on a sustained and massive scale (450 000 connections annually, of which the majority are in rural or peri-urban areas). In areas remote from the grid, there has been some private sector solar home system activity, but little community-wide publicly supported activity for off-grid household electrification (the community of Maphephethe in KwaZulu-Natal, and a project for farmworkers in the Free State being the principal active projects to date). A number of solar home systems projects are in an advanced stage of planning. Institutional use of solar systems has been implemented on a larger scale, with the Eskom schools project and the IDT clinic project being the major activities.

Grid capital costs per connection are primarily affected by the length of line extension required (and any bulk supply upgrading that may be required), proximity of households to each other, settlement size, topography, and the design After Diversity Maximum Demand. Revenues are strongly dependent on actual user consumption and, in some cases, non-technical losses (theft). Service costs are significant – of the order of R21 per month per household. Both operational and capital costs can be significantly reduced (by approximately 30%) if a limited-current supply option is utilised – 2.5A, or possibly 8A – rather than the more usual 20A prepayment meter option.

Off-grid household electrification costs, on the other hand, are not very sensitive to location of settlement with respect to the grid, proximity of households to each other (except for mini-grid), settlement size and topography. There is a significant capital cost sensitivity to design daily load, but little subsequent revenue link to actual consumption. Maintenance costs are significant, with replacement of batteries being required approximately every three years at a cost of R300. Estimates of service costs vary from zero (no back-up provided), to R16 (field experience is urgently required).

The costs and benefits of different electrification options from the user perspective are in part quantifiable, but in part more qualitative. For those that get a connection to the grid:

- Grid is cheaper for the user (connection fees in the range R50 to R140 and an energy tariff of 28c/kWh).
- A 20A grid supply has the potential to be used for thermal needs.
- Grid offers greater potential for income generating activities.
- Off-grid options tend to have a far higher cost *to the customer* (of the order of R40 to R120 per customer over a four-year financing period; cost can be less if user pays a tariff for service, as in a utility model).
- While off-grid options provide the same services that most householders actually gain from the grid (lighting and powering of TV and radio/hi-fi), the service is limited, and does not offer the potential to be used for cooking, heating water, space heating or refrigeration, which needs can be more effectively met through other energy supply initiatives).

Both grid and off-grid can help to improve the lighting and communication facilities at clinics, schools and other public facilities. Vaccine refrigeration can be effectively powered using photovoltaic powered systems. In both schools and clinics, grid electrification does, however, provide greater opportunities for supplementary improvements than most off-grid systems. In particular, cooking can be much easier. Water pumping, although possible and often economically viable using off-grid renewable resources or diesel pumping, is usually much easier to carry out, as well as cheaper, if the grid is available.

Thus, in summary, grid connection of a community offers significant advantages, and is the clearly preferred option, if it can be attained. Consequently, when comparing grid and off-grid options for a particular community, one is not comparing like with like. It is necessary, when making a selection, to include both direct financial costs and benefits in the analysis, as well as an understanding of the broader quantitative and qualitative differences.

Principal constraints to large-scale off-grid electrification activity are listed below.

1. There is uncertainty regarding future grid electrification plans, communities and off-grid service providers often having insufficient information on grid options to make good decisions about off-grid investments.
2. Rural communities express a strong demand for, and have a high expectation of getting, grid electrification.
3. There are difficulties in establishing appropriate financing for off-grid systems.
4. There are delays in achieving roll-out of an agreed subsidy from the fiscus for pilot-scale off-grid electrification projects.

The first two of these constraints highlight the need both for criteria and for public, transparent long-term grid electrification planning.

2.3 Criteria currently being used in electrification decision making

Current electrification planning is focused on grid rollout, with a primary emphasis being on the identification of projects in the short term (one to two year planning horizon). Longer-term plans are more general, and subject to change. There is generally little integration between grid and off-grid planning, although efforts are being made to change this. As a result, off-grid planning is sometimes invalidated by the unexpected arrival of the grid.

Minimisation of capital costs per connection is the main selection criterion within the Eskom-dominated rural electrification programme. This is primarily a result of the target-driven nature of the programme, coupled with an appreciation that the programme is not financially viable. Revenues generally do not cover the operating expenses, let alone the capital investment. Capital costs represent the largest portion of the 20-year NPV of projects, given the generally low consumption rates. Thus the principle way to minimise losses is to minimise the initial

investment. Capital cost criteria (maximum allowable cost per connection) used by Eskom do vary from region to region, in acknowledgement of the differing conditions in different parts of the country.

Both Eskom and the DBSA utilise a shared spreadsheet-based financial and economic cost/benefit analysis model. Subject to certain qualifications regarding the reliability and appropriateness of consumption and loss of revenue data used, the tool does provide a potentially very useful indication of project financial viability from the utility perspective, and of the potential economic costs and benefits to society as a whole. The results of the analysis are primarily used by Eskom for project acceptance/rejection decisions, rather than being used as one of the inputs to prioritisation.

Central to the financial analysis of grid electrification projects is an estimate of the electricity consumption growth rate in communities. Consumption plays an even bigger role in an economic analysis, as a 'willingness to pay' component comprises part of the benefits. Formal socio-economic surveys are not currently undertaken by Eskom prior to electrification decision-making. Thus the data used in analyses to support decision making is usually based on average data (often for the region), modified by windshield-type assessments of settlement conditions. This does not adequately distinguish between different settlements or between different groups of people within settlements.

Technical design criteria and guidelines for grid reticulation network on Eskom projects are not explored in detail here. There is, however, a move towards installation of lower capacity reticulation systems, transformers and bulk supply (design ADMD of 0.4-0.7kVA). This is motivated by capital resource constraints, and in line with a downward revision of expected consumption growth curves, and possible greater use of the limited-current supply options. The implications of such changes on future network extension and network upgrading budget requirements have not been assessed here. A national policy on the capacity of supply adequate for rural electrification has not yet been clearly articulated.

Off-grid technical design criteria are even less clearly articulated, although there is a general acceptance of the need to provide energy for household lighting, and radios and/or monochrome television. In principle, the importance of technical quality assurance for off-grid components and systems is acknowledged, although the mechanisms for assuring this are not yet in place.

Community facilities (schools and clinics) are considered in household electrification project CBA evaluation. Furthermore, there are dedicated programmes to supply electricity to community facilities. However, the general thrust of the main electrification programme is a drive to meet domestic supply point connection targets, and community facilities are not accorded the weight that they should be in general electrification planning.

Integrated planning and the need for better communication between different sectors involved in rural development are widely acknowledged within the institutions as being important, but are, however, difficult to achieve. Reasons given include: grid electrification planning being frequently in advance of other development planning; disparate allocation of responsibility for different functions; delays in the establishment of planning forums; lack of definite information; and a tendency for communities to focus on one service at a time in seeking to meet their needs.

Public involvement in electrification planning has taken place at various levels, with mixed success. While forums have facilitated prioritisation in some regions, in others strongly articulated inter-settlement equity concerns have resulted in small, partial settlement electrification options. Taking as a given the general high demand for grid electrification, Eskom has tended to avoid significant interaction with communities prior to a decision being made in this regard. This highlights a tension between a knowledge that communities should be directly involved in decisions, and at the same time sensitivity to the significant implications

of a decision not to electrify. This tension has been exacerbated by the lack of a real, worked out alternative to grid. The off-grid delivery and financing infrastructure is simply not in place.

2.4 Information and analysis to support decision making

The availability of data to support electrification decision making is improving rapidly. For most rural areas information is available on:

- settlement size (number of households);
- settlement area (which together with the above can be used to estimate the number of connections per km^2);
- settlement shape;
- location of schools and clinics;
- status of electrification in the area;
- some indication of water supply status;
- road infrastructure.

Although settlement specific demographic data is not as readily available, by mid 1998 it should be possible to link census data to 'enumerator areas', which will also give some indication of income and wealth in settlements. Information regarding informal and formal business activity in communities is generally not available. Furthermore, although a number of energy consumption surveys have been carried out, sub-regional variations can be significant.

2.4.1 Information requirements

Information requirements for electrification planning can be divided into the following areas:

- capital costs of particular options;
- lifecycle financial costs and expected revenues;
- lifecycle economic analysis (costs and benefits);
- consumption growth potential, and indicators thereof, as well as some indication of the load profile;
- community empowerment and involvement opportunities;
- settlement status;
- availability and status of public facilities and amenities (water, roads, health facilities, schools);
- potential for economic development and non-domestic demand;
- other energy issues in the area;
- development planing and development initiatives.

While the majority of the information feeds into the financial and economic analysis, some of the issues require a separate or more qualitative analysis.

If rational prioritisation of settlements for electrification is to take place, then it is important to identify key parameters that will differ significantly from community to community. The obvious one is capital cost, and this certainly requires the most attention. Also significant for grid projects, however, is the consumption rate, as significant differences in consumption levels have been noted between communities – Davis (1995) reports settlement average consumption per connection ranging from less than 20 kWh/month up to 150 kWh/month 30 months after electrification. The most commonly used indicators of potential consumption are income or wealth related measures, but there is some concern regarding the accuracy of income information, and the validity of the link between pre electrification income and future expenditure on electricity. This is an important area for further research.

2.4.2 Financial and economic analyses

Financial and economic analyses can be used in a number of different ways to assist electrification decisions.[1] It is important to establish the depth of analysis required, and the perspective of the decision maker using the analysis. From a review of analyses carried out for different electrification options, the following main points are noted.

1. From the customer perspective, grid electrification using a prepayment meter, at current connection and tariff rates is financially and economically preferable.
2. Grid electrification projects are generally not financially viable at current tariff and consumption levels (with life cycle NPV per connection of the order of negative R3500).
3. From a national perspective, economic analyses of rural grid electrification projects yield mixed results. A review of thirty projects in 1995 indicated that 60% of projects had a negative economic NPV, with an approximate normal distribution of the economic NPVs around zero (Matlhare & Steyn 1995). Davis (1997), using a similar model, but accounting more fully for the benefits, reported a positive NPV for the remote community of Mafefe. Solar electrification did not yield a positive economic return in the analysis carried out by Davis.
4. Off-grid systems are likely to have a low penetration rate at cost-reflective tariffs (as the user costs would be high for the service delivered). Reducing tariffs to levels more comparable with those of the grid (for the user) will mean that off-grid projects are also not generally financially viable without some measure of subsidy or very soft loan.
5. Off-grid options tend to be financially more attractive *relative to the grid,* where grid capital costs are high (remote, small settlements, low household density), and/or consumption rates low.
6. However, from an economic perspective, prepayment metered grid supplies are optimal over greater consumption and capital cost ranges.

As will be discussed later, financial and economic analyses are seen as essential to both project prioritisation, and technology selection.

2.4.3 Other factors to be included in electrification decision making

Economic and financial analyses do not capture all aspects relevant to electrification decisions. Certain issues are best dealt with as specific explicit criteria (for example, projects should not cause undue damage to environmentally sensitive areas). Others, such as the social developmental benefits attributed to electrification of community facilities can be dealt with through an index approach, with points being allocated on a score system for different electrification activities. Alternatively, they can be incorporated in economic analyses using explicitly defined (standard) cost and benefit parameters. Lastly, their relevance to decision processes can be qualitatively reported to decision-making bodies, and incorporated in an explicit, but not necessarily quantified, manner.

2.5 A 'best practice' set of criteria for operational planning

In an attempt to draw the work together, and present a basis for further discussion and development of criteria, a best practice set of criteria have been developed, and described within a decision-making approach. Key principles used in developing this approach are identified below.

---

1 In this report, the term 'economic analysis' is used to describe a modified and extended financial analysis, which explicitly considers the national view.

2.5.1 Electrification policy

Electrification is seen as a worthwhile endeavour, which aims to provide at least a minimum level of services to permanent households and communities in a sustainable manner, using resources in an economically efficient manner.

- By 'minimum level of service' is meant that households should be able to use electric lights for a few hours in the evening, and operate low-power entertainment and communications devices. Community facilities such as clinics, and schools should have access to the minimum electrical energy required for daily operation and communication.
- By 'sustainable' is meant that reasonable assurance can be provided of long term continued availability of the service, supported by revenues, and where necessary through defined and assured alternative resources (typically cross-subsidies).

Electrification activities should seek to maximise the benefits achievable, through supply of a higher level of service than the minimum level noted above, where this can be economically justified and where the extra financial cost (if any) can be managed and will not jeopardise the electrification programme or the industry.

The social and economic benefits of both the electrification process and the subsequent service delivery should be maximised through appropriate project design and management, involvement of community members, and through active identification and development of economically viable opportunities.

Situations where provision of electricity will facilitate broader economic development should be actively identified and developed.

2.5.2 Planning context and principles

Within the resource allocation process described above, operational level planning is assumed to take place:

- in regions small enough that political questions of geographically equitable resource allocation are not relevant (these should be dealt with at the strategic level);
- within a reasonably defined resource base (thus planners have an idea of the magnitude of resources available);
- primarily within a programmatic fashion, although provision is made for project specific decisions;
- in a series of iterations, with decisions being gradually firmed up as further information is gathered, and the necessary consultation takes place;
- in a flexible manner, with evaluation of projects and adjustment of planning criteria taking place on an ongoing basis, and with a sensitivity towards differing levels of data availability;
- in a manner such that long-term grid planning is prioritised and publicised, to allow both communities and service providers to make informed decisions about off-grid investments;
- in a multifaceted funding environment, but with decisions strongly influenced by the national best interests.

This is consistent with (but not necessarily dependent on) the possible establishment of a National Electrification Fund.

2.5.3 Criteria for first level decision-making

Decision making will take place in a number of stages. The first is to allocate settlements to one of three categories:

- those where *grid* electrification is definitely the preferred option;
- those where *off-grid* technologies are readily identified as being more appropriate (remote, small communities); and

- an *uncertain* area for which decisions are not as readily made.

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

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

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

The 'grid prioritised' approach:

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

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

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

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

For both approaches, due attention should be paid to:

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

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

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

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

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

1. Settlements which are of significant importance (relative to others) in the region, should be moved up the priority list. These can be identified through the following indicators:
   - settlement size;
   - presence of schools, health facilities, and public administration offices;
   - location with respect to important transportation routes.
2. Settlements that are likely to contribute to, or benefit from, planned regional development initiatives should move up the priority list for electrification.
3. Settlements which have inadequate water supply, or for other reasons are not viable as permanent places of residence, should be moved down the priority list (unless defined plans are in place to improve the situation).

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

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

2.6 Criteria for final approval of projects

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

- have an assured demand for the service offered;
- explicitly consider less easily quantified or identified costs and benefits;
- identify and utilise opportunities to maximise the benefits of electrification;

- involve the community in project implementation and operation, where appropriate;
- respect environmentally and culturally sensitive sites and impacts;
- have the necessary technical, financial, project management and community liaison capacity;
- meet quality assurance and technical standards requirements;
- ensure long-term sustainability of service provision (both from a financial perspective), and with respect to maintenance provision);
- have investigated long term grid planning in the project area and incorporated this into the project evaluation.

3. Closing comments

The intention of this work was to present for discussion, a set of recommended criteria to support electrification decision-making. At the time of the research South Africa did not have a clear electrification policy, and it would be a mistake to suggest that our recommendations are an accurate reflection of the still to be finalised electrification policy and strategy. It is far more important that this paper and the detailed reports on which it is based should be seen as a reasonably detailed presentation and analysis of issues that could inform and stimulate debate. We sincerely hope that these resources will help those involved in setting priorities and establishing procedures for future integrated planning to grapple with the issues, and thereby to identify and agree on appropriate criteria in a considered and informed manner.

References

Banks, D I, 1998. Criteria to support project identification in the context of integrated grid and off-grid electrification planning. Energy and Development Research Centre, University of Cape Town.

Davis, M, 1995. Electricity consumption growth in newly electrified settlements. Energy and Development Research Centre, University of Cape Town.

Davis, M, 1997. A financial and economic analysis of two electrification projects. Energy and Development Research Centre, University of Cape Town.

Matlhare, M & Steyn, G 1995. Report on CBA Project. Eskom Electrification Planning, Megawatt Park.

Thom, C, 1998. Criteria for the allocation of grant funding for electrification to provinces. Energy and Development Research Centre, University of Cape Town.

Appendix: Summary of criteria for operational decision-making

Contents of appendix

Introductory note

The recommendations regarding criteria developed in Banks (1998) have been summarised here for ease of reference. The reader is however cautioned. As a summary of a complex field, this annex is by nature incomplete. Process is an important component of decision making, and space does not permit presentation of the process here. Of particular concern in presenting the summary, is that involvement of communities and different levels of decision-makers in the process is not adequately reflected. Chapter 5 of Banks (1998) provides a more considered rationale and contextualisation of criteria within the planning process.

4. Criteria for 'first pass' decision making

Decision making will take place in a number of stages. The first is to allocate settlements to one of three categories:

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

Categorisation into these three areas can be achieved relatively easily using readily available data, preferably using a GIS data management system. The *uncertain area* should be large enough such that few settlements are incorrectly placed into the *grid* or *off-grid* area. Criteria to be used are:

1. Indicators of lower cost:

- settlement size
- proximity of households to each other (density)
- distance between settlements of similar size (or if closer to the nearest grid line)

2. Indicators of greater potential benefit from electrification

- number and location of public facilities such as clinics and schools
- existence (or not) of significant business and/or agricultural development
- income or other wealth related data
- knowledge of related development plans in other sectors (integrated development)
- site specific opportunities for economic benefit

5. Criteria to be used to narrow the 'uncertain band'

Two approaches are suggested, depending on the circumstances. In a regional planning exercise, it is recommended that the *grid prioritised* approach be followed. For individual project level decision it will sometimes be more appropriate to use the *rational technology* selection approach. The approaches are illustrated in figures 1 and 2.

Note: in both cases more detailed analysis and information is required compared to the above 'first pass' decision processes. However, the focus here is only on the settlements that are more difficult to prioritise. Such detailed work will not be required for all settlements.

Figure 1: Grid prioritised sub-regional planning

Key principles and assumptions

- Grid connection is the strongly preferred option for a variety of reasons (not all readily quantified).
- Accept that economic, financial and social benefits analysis is adequate to prioritise projects which deliver comparable benefits (at least in the first instance).
- Acknowledge that economic analysis is a relatively blunt instrument to rank options that deliver significantly different benefits (i.e. that 20 A grid vs. off-grid decisions cannot easily be made on the basis of techno-economic analysis, particularly in borderline cases).
- As a result, off-grid areas are defined primarily a result of carefully prioritised long term grid planning, carried out in the context of a defined financial and institutional grid electrification resource.

Steps in the planning process

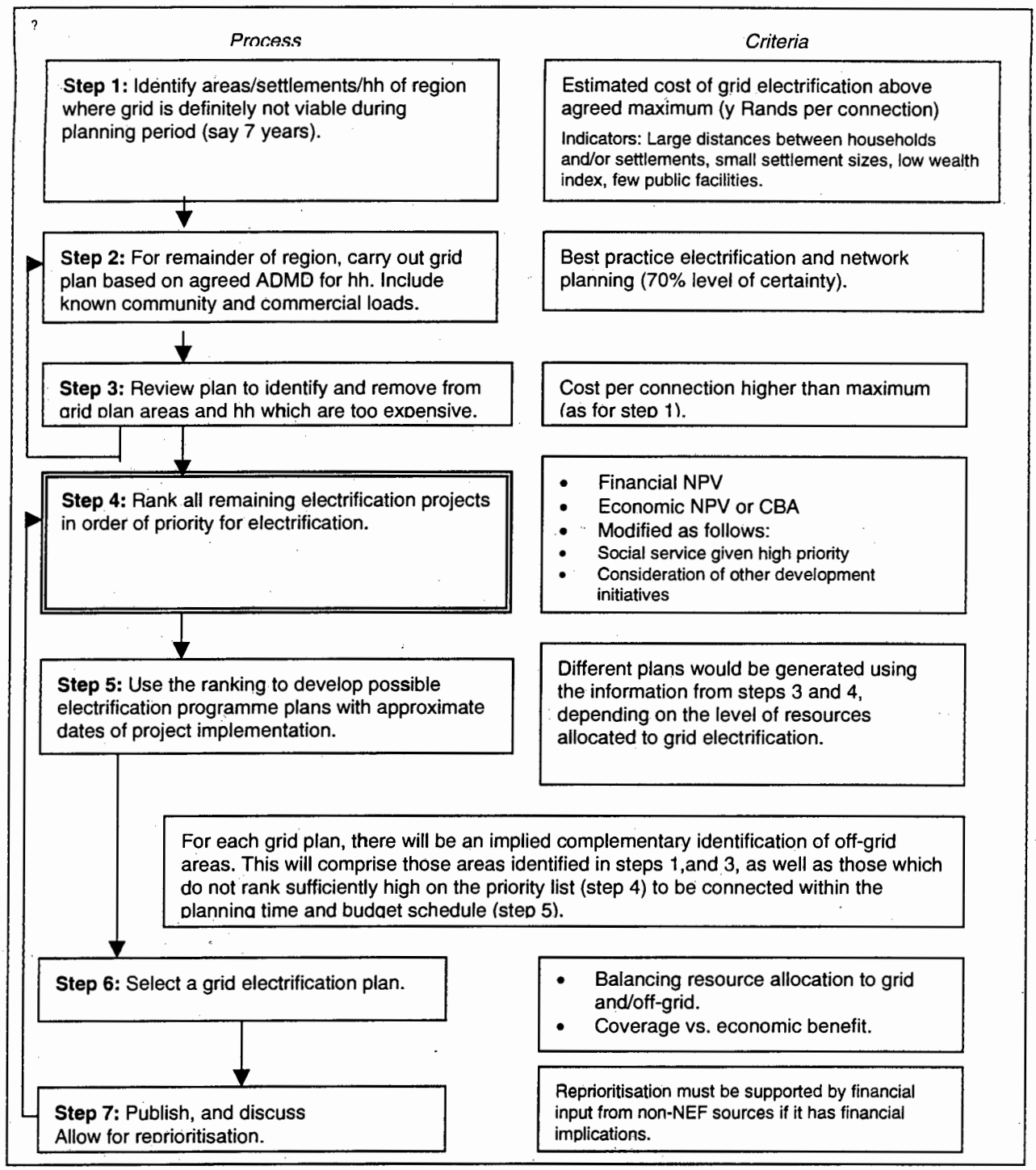
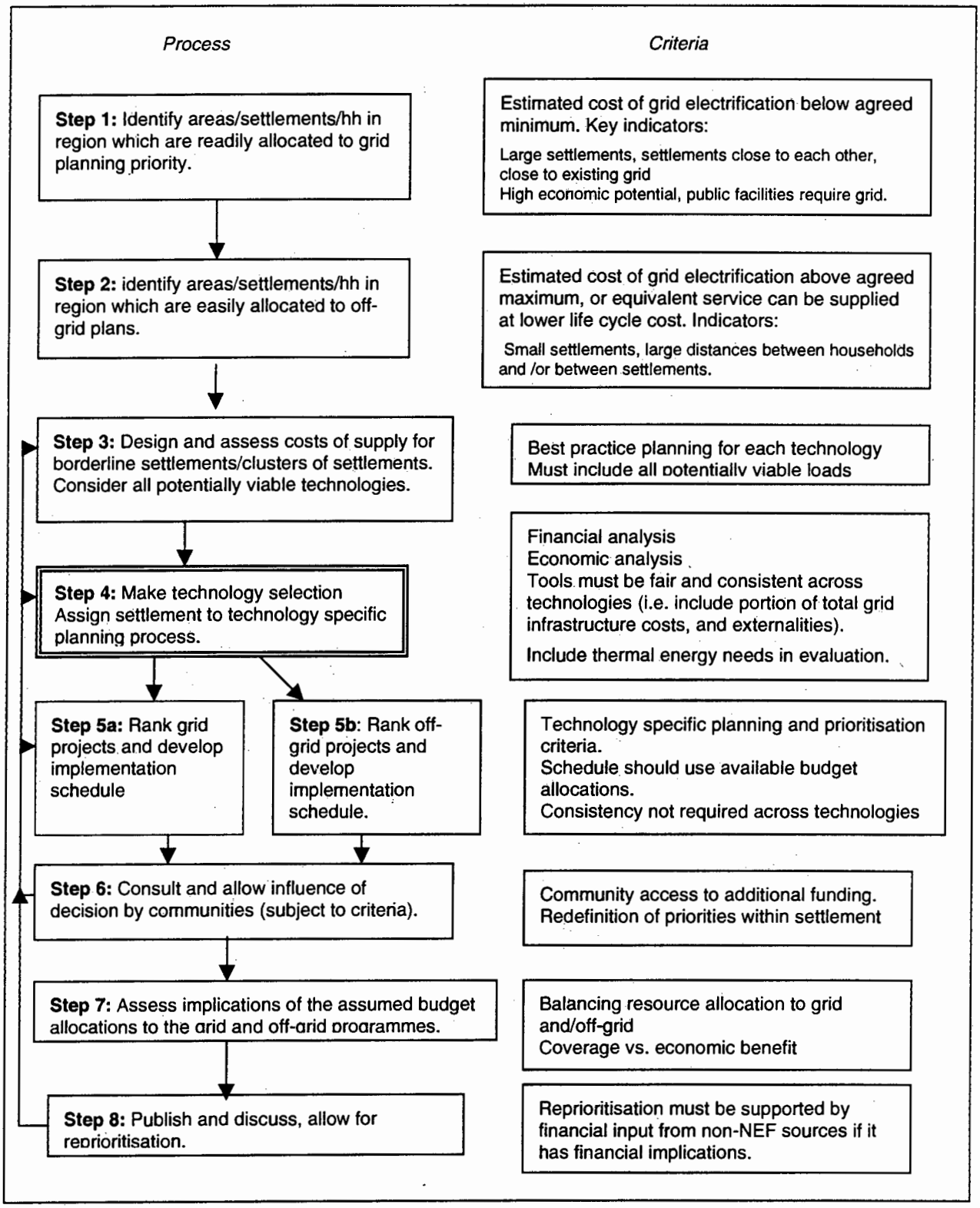


Figure 2: 'Rational technology' selection approach

In the more critical borderline cases, a careful technology choice is made, rather than allowing the grid/off-grid decisions to be essentially a by product of a grid planning exercise. This approach requires:

- An accurate social, technical and economic evaluation of grid / off-grid costs and benefits which has a sufficient level of confidence to allow robust grid/off-grid decisions.
- In order to improve decision making accuracy, it is recommended that thermal needs (and energy supply options that meet these needs) be included in the evaluation.



5.1 Grid prioritised approach

5.1.1 Information required

- Estimated capital cost of grid electrification with a level of certainty of approximately 70%
- Number of permanent households and population in settlement
- Percentage of households in community that would be electrified
- Assessment of the number and scale of business activities in the community
- Status and number of schools and clinics in or close to settlements
- Identified specific opportunities for extra benefits from electrification (e.g. water supply, agricultural development, specific entrepreneurial activities)
- Wealth or preferably better indication of expected consumption and willingness to pay
  - woodfuel scarcity or strong commercial woodfuel market indicating high priority for thermal applications
  - regional information on technical and non-technical losses

5.1.2 Prioritisation

Using the above settlement specific information, settlements should be prioritised for grid electrification using in the first instance:

- financial analysis
- economic analysis

The choice of whether to place primary emphasis on the financial or economic analysis will depend in part on the electrification strategy and policy adopted (see main report for discussion).

Note that financial and economic analyses are already carried out as part of the electrification planning process. The above does not present significant departure from the status quo, except that greater emphasis is placed on gathering settlement specific data, and on incorporating business and social services more fully.

5.1.3 Adjustments to prioritisation

Adjustments to the prioritisation list should be made on the basis of the following:

1. Settlements which are of significant importance (relative to others) in the region, should be moved up the priority list. These can be identified through the following indicators:
   - settlement size;
   - presence of schools, health facilities, and public administration offices;
   - location with respect to important transportation routes.

   (Note that, in both cases, the economic analysis will have accounted for this in some measure already, and it is thus not clear that ranking should be altered on these grounds).
2. Planning authorities should actively engage with other planning and development initiatives in the region, to share and gather information. Of particular importance would be 'Development Corridors' and 'Spatial Development Initiatives'. Settlements that are likely to contribute to, or benefit from, these planned initiatives should move up the priority list. Due cognisance should be taken of appropriate project scheduling.
3. Settlements which have inadequate water supply, or for other reasons are not viable as permanent places of residence, should be moved down the priority list, unless defined plans

are in place to improve the situation. If supply of the grid will contribute to this improvement, then this should be included in the economic analysis.

4. This review of the priority listings should be carried out with the aid of area maps, which show the relationship of settlements to each other, and to the major proposed grid extension routes. Due cognisance will have to be taken of the interdependence of specific settlement project viability on the electrification of nearby settlements.

5.2 Rational technology-based decisions

Criteria used for an explicit comparison of technologies would be similar to those described above, with the following additional points noted.

- The capital and life costs of grid (and off-grid) technology used in the financial and economic analysis should include:
  - externalities on the generation side (costs);
  - health and related externalities on the customers side (generally benefits);
  - the full costs of grid extension should be factored in (including a share of bulk supply); however, as for the grid prioritised approach, sharing of bulk supply costs between different settlements should be applied;
  - the effect of the peaky nature of domestic loads on the cost of electricity supply should be included in the analysis
- Economic opportunities (and constraints resulting from supply choice) should be reviewed and included in the analysis.
- Given certain off-grid technology's considerable cost sensitivity to load magnitude and load factor, it will be necessary to identify all significant loads, and include these in the preliminary design and analysis (water pumping, health centre, schools, SMME requirements).
- As grid technology has the potential to meet some thermal needs, but off-grid technology usually does not, it is recommended that the costs and benefits of energy for thermal energy needs be included in the analysis.

Again there are important, as yet unresolved concerns regarding placement of emphasis on financial or economic analysis. Please refer to the main report for discussion of this.

6. Criteria for final project acceptance

The above criteria would be primarily used in the planning process. The following table presents a proposal for criteria to be used for final project acceptance by funding authorities.

Table 2: Final project acceptance criteria for electrification projects – a proposal

	Requirement
1	**Demand and user acceptance**
1.1	The application will include a signed statement from the local authority (or other appropriate body acting as a representative of the community), to the effect that the proposed electrification plan is acceptable to the majority of households in the area.
1.2	The number of connections assumed in the analysis below should be supported by commitments from potential customers or some other indication of expected demand
2	**Financial and economic assessments**
2.1	A financial analysis from the consumer's[2] perspective should indicate that the assumed uptake rates and the assumed load growth profiles are realistic.
2.2	A financial analysis for the entire project should indicate that the operational costs will be met over the longer term. Alternatively, assurances must be given by the service provider that the operation and maintenance costs will be covered by a quantified cross-subsidy from defined sources according to an explicitly agreed policy.
2.3	The application should specify the minimum subsidy (if any) required to make the project financially feasible for the service provider.
2.4	The financial analysis should indicate the NPV of the entire project.
2.5	The application should include a risk assessment .
2.6	The application should indicate the sensitivity of the financial analysis to: • load growth rate; • uptake rate, esp. in the case of off-grid; • cost of energy; • operation and maintenance costs; • tariff or loan repayment rate; • other factors identified in risk assessment (if amenable to sensitivity analysis).
2.7	The applications should incorporate an economic analysis[3] which reports separately: • benefits as a result of household connections; • benefits as a result of community service connections (schools, clinics, etc); • benefits as a result of non-household (business) economic activities that will be affected by the project; • costs – again broken up into the above categories.
2.8	Where there is a question of technology choice, both an economic and a financial analysis should be presented for the next best technology option, and reasons motivated for the choice made if a least cost option has not been followed.
3	**Not-easily quantified costs and benefits**
3.1	The application will include comments on benefits and costs of the electrification project which have not been fully accounted for in the financial and economic analysis
4	**Maximisation of benefits**
4.1	The context of the project within the broader development framework and any other planning initiatives in the region should be articulated.

2 Consumers from lower, middle and upper income groups should be considered. Non domestic consumers should also be considered.

3 The economic analysis should be carried out using a standard methodology so as to facilitate comparison between projects

	Requirement
4.2	The application should indicate what opportunities for economic development have been incorporated in the proposed plan.[4]
4.3	The application should indicate what measures have been and will be taken to maximise the benefits of electrification to end users.
4.4	The application should include details of, and expected success of, measures taken to maximise demand where this is economically and environmentally efficient.
5	**Community empowerment and involvement**
5.1	The application should indicate what steps have been taken to: • involve community members in the project implementation; • use community or local contractors in project implementation; • involve community members (if appropriate) in longer term project operation (vendors, maintenance).
6	**Environmental and cultural sensitivity**
6.1	The service provider should provide assurance that due consideration has been given to environmental and cultural heritage considerations in the project planning and location of equipment.[5]
7	**Capability and quality assurance**
7.1	The service provider should demonstrate that it has the necessary technical, financial, project management, community liaison capacity to undertake the project.
7.2	There should be assurance provided from the applicants that the applicable technical standards and quality assurance measures and codes will be applied. These should include reference to system performance.
7.3	There must be adequate provision and capacity for long term, sustainable maintenance (in the case of renewable energy systems, this criterion should be expanded).
8	**Public planning**
8.1	The application will indicate probable grid extension plans for at least the next five years within a 15 km radius of the project site.[6]

Reference for Appendix

Banks, D I, 1998. Criteria to support project identification in the context of integrated grid and off-grid electrification planning. Energy and Development Research Centre, University of Cape Town.

4 This may mean, for example, that bulk lines have been routed close to water abstraction points to facilitate installation of pumps, rather than simply following the access road.

5 An environmental checklist should be compiled, to ensure that all necessary considerations are checked.

6 This serves two purposes. Firstly, it facilitates assessment of possible future benefits of infrastructure being laid. It also helps to ensure that long term planning takes place, and is public.

EDRC REPORT SERIES

Criteria for integrated grid and off-grid electrification planning: Summary paper

D I BANKS
C THOM

ENERGY & DEVELOPMENT RESEARCH CENTRE
University of Cape Town