D. I. BANKS

Geographic Information Systems for Electrification

SCOPING STUDY

Final report

Report prepared under the direction of steering committee with members from:

Eskom
Development Bank of Southern Africa
Council for Scientific and Industrial Research

HILTON TROLLIP

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Project scope and resources

This report consists of 3 parts:

Part 1 - Project approach and focus

Part 2 - An analysis of the situation regarding GIS and electrification in South Africa.

Part 3 – A "chopping block" project proposal for promoting and establishing GIS for electrification in South Africa.

It is not within the scope of the study to either develop or reproduce highly detailed technical information on GISs. Instead the objective is to present relevant information leading to conclusions which are then used as the basis for a "chopping block" project proposal for a project on GIS development relevant to electrification.

Fifteen person days were allocated to the project. These were used as follows:

Activity	Days
Initial interviews and discussions	1
Agree on terms of reference with steering committee	0.5
Detailed review of EDRC electrification criteria project draft findings	1
Interviews and discussions: round 1	3
Prepare input to electrification criteria workshop	.5
Input and discussions at electrification criteria workshop at DBSA	1
Prepare interim draft report with main findings and conclusions	1.5
Interviews and discussions: round 2	2
Draft report	3
Discuss draft report with steering committee	1
Final report	2
Total	16.5
Disseminate results (Not resourced as part of project) ⇐ **WE ARE HERE**	0

Table 1 – Sequence of project activities

The study interacted closely with a project involved with developing criteria for electrification[1]. Each of the study activities has led to progressive refinement of this report. Details of the organisations and individuals involved in the meetings are presented in appendix B. The draft report was approved with very minor changes by steering committee members. These have been incorporated in this final report.

[1] Banks D I, [1998; in preparation]. 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, Cape Town.
Thom C, [1998; in preparation]. Criteria for the allocation of electrification resources to regions and provinces. Energy and Development Research Centre, University of Cape Town, Cape Town.

Part 1

Project approach and focus

Approach taken

The South African national electrification programme seeks to make major investments in electrification to facilitate economic and social development goals. In an environment where there is a notable lack of policy individual institutions (Eskom, local authorities, DBSA, NER and IDT) have achieved considerable success in implementing the programme. However, lack of effective co-ordination through clear policy has led to a situation where the institutions have had to follow their own paths and this has resulted in problems with issues of the particular requirements of the various institutions not necessarily being aligned.

In interviews with these institutions many problems with this lack of alignment have been reported in terms of development and maintenance of an electrification GIS. The most important issues are access to data and data maintenance. Firstly, individual institutions are reluctant to give away access to data that they have developed at considerable cost to themselves. Secondly, data maintenance involves considerable costs and effective co ordination.

In discussing these problems during interviews the debate would often turn to normative ideas around, for example, the ***right*** of an organisation to not share data until data recipients had paid a fair price to contribute to development costs. It was the experience that this approach to the discussion only led to hardening of positions and a resulting effect of institutions developing their own separate GIS databases and systems instead of arrangement being reached for sharing.

It is in the light of the above that the primary aspect of the project approach must be made clear. The project seeks to review requirements for electrification GIS in terms of the ***national interest***. Thus while recognising the necessity of working towards a situation where fair contributions are made by data users in terms of data development and maintenance costs, the project seeks to establish solutions whereby the national interest can be served by looking at ways in which requirements for electrification GIS, in national terms, can be established and whereby important data sets, which can be seen as important national assets, can be shared.

The second important point as far as the project approach is concerned is the focus on attempting to provide a way forward. So, whilst much effort has been put into assessing the situation, the primary output of the project should be seen as the project proposal "chopping block" in part 3. It is very important to recognise that it was impossible to get full agreement on exactly what the way forward should be. This is in fact the crux of the problem. Because major players have already often progressed a far way down their own separate paths it is difficult to get together back on the same path. Nevertheless, the steering committee decided that maximum benefit would result if a specific concrete proposal were made for a way forward. Thus the project has taken the step of making a proposal. The purpose of the proposal is to promote concrete discussion to resolve institutional issues around data access and maintenance and how costs will be covered.

Focus of the project

Because this is a short scoping study with only 15 days allocated to its production the initial discussions with the most important stakeholders and the round 1 of interviews were used to provide a tight focus for the project. The main area that has been chosen as the focus is institutional issues relevant to GIS for electrification as follows:

1. Access to data for GIS

2. Data maintenance

3. Financial and intellectual property aspects related to the above three issues.

4. In addition to these institutional issues the project will attempt to give an indication of the extent of agreement on data content[2] in two ways. Firstly, a list of the most basic data required over the first phase of use of GIS for electrification policy and implementation. Secondly, a list of data required in the subsequent phase which may require more detailed data.

Rationale for this focus

Reason for focus on data (as opposed to focussing on GIS systems)
Users and GIS implementers agree that commercial GIS technology has reached the state of maturity and standardisation that, provided a major standard commercially available GIS is chosen, the choice of GIS is not an important or central issue.

Reasons for focussing on institutional issues related to data (as opposed to data content)
At the first steering committee meeting, at which the scoping study terms of reference were agreed on, the committee agreed that the project should primarily be informed by potential users' requirements. In other words, GIS development should be driven by users' requirements, not the other way round.

This turned out to have important and very useful implications for the project in terms of the development of a clear focus. Possibly, the major initial finding of the project was that the chief potential users of the GIS do not require highly detailed data either for electrification policy development or implementation. The emphasis is more on ***robust*** processes in terms of use of data, access to data and maintenance of data.

Linked to this major initial finding was another important finding. From interviews with the major current users of data, it appeared that for most areas of South Africa for which electrification data is relevant either:

- Data sufficient for electrification policy and implementation exist, or;

- Projects are underway and adequate data will soon be available in GIS format.

Thus, data development issues are not of major importance. Instead, institutional issues related to access and maintenance of existing data, or data that will soon exist are what are important. Thus, the section of the project dealing with a review of the present state of GIS and data development restricts itself to confirming that the rather modest data requirements of GIS users relevant to electrification are either met by current data sets or by data under development.

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[2] Note: "Data content" refers to what the data is about, for example "position of houses" or "household income". Data content is only on aspect of the data. Other aspects, such a data quality, access to data and maintenance of data are equally important in the context of data used for planning electrification.

A last important finding was that while there seems to be some clarity as to which institutions and organisations would require access to GIS data relevant to electrification, agreement on how electrification criteria will be applied to the data is relatively undeveloped. Currently, provincial allocations and project selection are done according to very basic criteria using simple methods.

Part 2

Situation regarding GIS and electrification

Background

Background - the South African Electrification programme[3]

South African electricity distributors have connected some 2.5 million additional households to grid electricity since the beginning of 1991 as part of an intensive programme. This means that about half the households connected to electricity at the end of 1997 were not connected seven years ago. The current rate of electrification is more than 450 000 connections per annum.

The electrification policy has largely been driven by electrification target connections of some 450 000 connections per annum set in the RDP. This policy has been effective over the initial period of intensive electrification largely because at the beginning of the programme the prevalence of un-electrified urban households was so large that it was largely obvious where connections should be made.

However, by the end of 1996, official National Electricity Regulator (NER) statistics indicated that 79% of urban households and 27% of rural households had been connected to electricity. While many rural households still do not have electricity urban areas are approaching saturation and rural connections are becoming more expensive as the distance from the grid increases and average monthly kWh consumption figures drop.

In addition to the grid electrification programme, a large-scale Solar Home System (SHS) rural electrification programme, possibly involving 1.2 million rural households, has been announced by the South African Department of Minerals and Energy . There has been virtually no delivery in this area. The requirement for co-ordination of SHS electrification with grid electrification has become a key obstacle to SHS installation. The SHS has not yet got off the ground, largely because many households either expect grid electricity or believe that if they accept SHS they will not be eligible for grid connection. Progress in SHS delivery requires clear electrification policy which makes provision for effective co-ordination of the grid and off-grid programmes.

Until now the grid programme has been driven by annual connection targets. The selection of electrification projects has not been according to nationally agreed criteria and the two authorities responsible for selecting projects, namely Eskom (to spend roughly R900 million in 1998) and the National Electricity Regulator (to spend roughly R300 million in 1998) use different approaches.

+ CA FUNDING.

[3] The reader is referred to Banks (1998) for an excellent overview of the electrification programme.

Background – electrification policy and planning

South Africa's electrification policy

Apart from a commitment to make a certain number of grid connections each year (about 450 000 per annum at present) South Africa has no electrification policy. Currently grid electrification is funded largely by Eskom and the DBSA with the IDT playing a role in electrification of clinics.

How electrification funds are allocated and projects are selected

A. Grid connections

In terms of the numbers of household connections made annually allocation of funds to most grid electrification projects is decided in one of two ways depending on the distributor undertaking the project namely Eskom on the one had or local authorities on the other. (There are plans underway to integrate these two processes but in the meantime GIS databases are being separately developed by the two organisations responsible for the different areas namely Eskom and the NER).

Eskom, the DBSA and the National Electricity Regulator have developed a number of criteria and methodologies for assessing electrification projects. Some of these include sophisticated considerations. The reality of the potential situation is that at present, although assessments may be carried out, the actual result of electrification planning is that the yearly RDP connection targets drive the programme. An important aim of instituting more rational planning will be to incorporate the use of GIS electrification databases in a practicable manner. This will mean that over-ambitious aims of including very sophisticated methodologies will need to be avoided until success has been achieved in the integrated use of initial more basic data and methodologies.

1. Eskom projects

Where Eskom is the distributor, internal communications within Eskom are used to decide which projects get funded. The amount allocated to this side of the electrification programme in 1998 is approximately R900 million.

Banks (1998) provides an excellent overview of the Eskom process from regional decisions on targets and allocation of electrification funds down to implementation of projects. Although Eskom takes most of the decisions, an important input is made by the DBSA. Banks (1998) also describes this. Although some use is made of the HELP GIS to provide information the Eskom regional allocation and project selection processes could still be fairly described as a complex arrangement of internal Eskom processes. A more systematised methodology which was integrated with other electrification and national policy would offer significant advantages to the current arrangement.

2. Local authority electrification projects

About 400 local authority distributors apply to the NER for funding. (This is used as an effective subsidy and cannot be used for, for example, public lighting, operating costs and costs that can be recovered from consumers). A body named the "*External Electrification Funding Evaluation Committee*" sits annually and allocates funds according the following method.

Each province is allocated a proportion of the total funding available on the basis of a two component weighting with equal weight. The first part is a factor indicating the "development needs" of the province on the basis of calculations done by the Development Bank of Southern Africa. The second part is the %-non-electrified houses in the province.

Thom (1998) provides a detailed overview of the principles and criteria used by the NER to guide provincial allocation of electrification funds.

After each provincial allocation is made each local authority project application is considered on its merits by the *External Electrification Funding Evaluation Committee.* The committee attempts to approve at least one project per local authority.

The NER process is simple and robust but, as with the Eskom process, integration of the NER process into a national electrification planning arrangement and national policy will result in significant benefits.

In summary it can be concluded that in the absence of policy, and an integrated rational programme, planning agencies that have been charged with carrying out the electrification programme have had to construct a rather crude basis for allocating resources and selecting projects. Many representatives of the agencies express a concern that lack of adequate planning is wasting significant resources either in terms of ineffective allocation of the resources or inefficient application of the resources. There is overwhelming support for the opinion that there is an urgent need for an integrated national planning process. The same opinion supports the use of GIS based data for development and implementation of this.

B. Off-grid provision

1. Solar home systems

In 1996 government indicated intentions to facilitate provision of up to 1,2 million solar powered home systems but apart from this statement and the establishment of an organisation named Refsa, (which has subsequently been absorbed into Department of Minerals and Energy) there is has been no indication as to how this is to be achieved. No systems have been installed under this initiative.

One of the major obstacles to the SHS programme has been the complete lack of integration of the grid and off-grid programmes. Without knowledge of plans for grid electrification it is very difficult to persuade potential SHS users to commit themselves to investing in SHS. Rational planning using GIS is one of the most promising options for enabling the SHS programme.

2. Schools and clinics

The IDT uses a GIS to produce information to support decisions on technology choice between grid, diesel genset and PV systems for clinic electricity supply. The main criterion used is comparative costing based on the distance from the electricity grid. Once again, integration of grid extension planning with PV-powered systems planning for schools and clinics using a GISs would be an advantage although this is not as critical as for the SHSs.

Background - the need for improved electrification planning

The situation described above has led to recognition that electrification funds are not being used optimally. The target based method is essentially problematic as is the lack of an overall electrification policy. As an alternative to targets the following overall objectives have emerged in discussions as useful for guiding better electrification planning policies and practice.

1. Equity considerations at the national level – electrification funds should be directed to provinces in an equitable manner according to agreed criteria of needs and effective utilisation of funds.

2. Transparency and fairness – recipients of electrification funds should perceive decisions as to who receives electrification and who doesn't as fair and transparent.

3. Economic considerations – electrification funds should be invested where they will be effective in terms of delivery of social needs or stimulation or support of development.

4. Efficiency – the electrification programme should be executed to deliver as much as possible given limited funds.

5. Co-ordination with the SHS programme – SHS on a significant scale will only be possible when forward grid planning becomes clearer. The ideal situation would be for the off grid and grid programmes to be planned and implemented as one integrated programme.

To achieve these objectives clear policy, planning methods and plans are required. To make these plans criteria[4] need to be applied. The primary motivation for using GIS in electrification is thus as an effective tool to achieve the objectives above.

Requirements of electrification GIS - uses

This section provides an overall description of what the study has concluded would be "realistic uses" for an electrification GIS. The terms "realistic uses" is specifically chosen here because there is a danger of expecting powerful tools such as GISs to do too much. For example, one could imagine, with sufficient data and a powerful enough GIS, the GIS tool could be used to mechanistically allocate electrification funds down to the lowest level and provide detailed plans for electrification projects.

However, while GIS can provide an important input to planning, they cannot be a substitute for very important processes involving interactions between electricity distributors, communities to be electrified and funders. These interactions often have to consider complex issues that are not appropriate for mechanistic resolution by the functions offered by a GIS tool.

NB: Thus, for the purposes of this study the electrification GIS is limited to providing input to the electrification policy and planning process. It is cannot be a substitute for the processes of interaction between the ESI and electricity users nor can it be a design tool.

Uses for electrification GIS

Given the decision on the limitation above the following areas of use have been identified for electrification GIS.

1. Electrification policy
   - Estimating potential results of various electrification policy options i.e. sketching scenarios.
   - Overall planning of electrification

2. Allocation of funds: provincial level

3. Allocation of funds: local distributor
   - Prioritisation of projects

4. Long term planning: grid / off grid

5. Integrated development planning

[4] See Banks and Thom mentioned in footnote 1.

6. Support for implementation
   - marketing / community interaction

In addition to the direct uses listed above GIS systems also facilitate data verification and maintenance as an integral part of their structure and use. For instance, when data is portrayed graphically in a spatial manner data anomalies become obvious because of the easy comparison with surrounding data. This is not an actual use in respect of electrification but is an important capability of GISs.

Background - use of GIS in electrification to date

The slide below indicates major points in the development of electrification GIS in South Africa.

Electrification data development

- pre - '94- Complete data fragmentation
- EPRET**[1]
- NELF demand side GIS**[2] - NEES
- EDRC/ DMEA
- Eskom / D.Housing GIS "HELP" database
- IDT GIS database
- Eskom HV/MV network digitisation
- Eagle(1:50 000), Merge(cadastral),Eagle(ea's)

History of electrification data and GIS

**[1] Energy and Development Research Centre at University of Cape Town produced national, regional and local database of household energy usage

**[2] Eskom supported development of GIS containing data on electrification status countrywide.

Before development of the NELF demand side database was begun in 1993, GISs had not been used for electrification in South Africa. Data had been been highly fragmented because of the homeland system and apartheid urban planning. From an official point of view, South Africa had a number of "independent states" within its borders, such as the Transkei. Thus official South African statistics did not include these areas. Also, large "illegal" urban settlements were not recognised as being permanent and thus not included in statistics for planning purposes. It is the ex-homeland areas and ex-illegal urban settlements areas that are now the primary focus of the electrification campaign.

Various organisations, such as the then Development Bank of Southern Africa and the Urban Foundation compiled statistics which included homelands and unofficial urban areas. However, these relied on estimates and models of population and there was controversy over their accuracy.

The Eskom funded NELF demand side GIS was the first attempt to gather available information and consolidate this into one computerised database and GIS system to inform basic electrification policy and planning. The idea behind the NELF GIS was to get an overall idea of the national electrification situation in a spatial dimension. Project personnel from the NELF GIS project moved on to the two database projects described below which are currently used for electrification.

The first database based on the NELF project, managed by the NER, is used as a basis for allocating the approximately R300 million by NER structures and consists of updated NELF data.

The second database based on the NELF project is the HELP (Housing and Electrification Planning) database. On the basis of Eskom's experience with the NELF GIS experience, Eskom embarked on the HELP database project. To date, investment in the HELP database exceeds R15 million. This investment has largely been effective and this has resulted in HELP becoming the most important national resource in terms of electrification planning data. Maintenance and extension of HELP is continuing.

The Independent Development Trust also has an extensive database used as mentioned previously.

Background - current and future developments in databases and GIS

Both the NER and Eskom are continuing with development and extensions of the databases mentioned above. However, as a result of experience in the HELP project the large scale of investment required for data development has been recognised. Also, impracticality of duplicating this investment means that future electrification GIS data will almost definitely be based largely on HELP.

In addition to HELP there are also many other databases under development. Compared with the previous dearth of development planning data relevant to electrification planning (and other social services for the homelands and poor urban communities) there is now much more activity. A brief (and not necessarily complete list) would include:

Data/GIS projects directly relevant to current electrification needs

Project	Client	Description, relevance to electrification	Complete
1996 Census	South African Central Statistical Services	• Census data for all households in South Africa. Includes services (water, electrification etc) linked spatially to other data sets via enumerator area GIS coding and thus provides very powerful data set.	Data for linking to "EAGLE" (see below) ready in April 1998
Maintenance and dissemination of HELP database	Eskom	• Project to maintain HELP and to integrate it with other projects such as EAGLE below. • Eskom is also negotiating with parties interested in having access to HELP.	
Eskom / CSIR South African renewable resource database	Eskom TRI CSIR	• A GIS-based decision tool to assist selecting the most effective electricity supply for areas not currently connected to the grid. • This is a relatively large project that would seem to cover most needs for an electrification GIS database.	4 year project beginning May 1998
Project *"EAGLE"*	South African Central Statistical Services & the Independent Electoral Commission	• GIS code enumerator area (E.A.) boundaries: classify and name each boundary. • Describe services (e.g. electricity, water, sewerage, roads) in each E.A.	May 1998

		• Link all existing HELP village data to EA's. • The link to EA's will allow '96 census data to be used in conjunction with other spatial data and thus provide electrification with an extremely powerful data-base.	
GIS code Eskom HV/MV network	Eskom	• Digitisation of the Eskom HV/MV grid in a consistent format that can be linked to HELP. The investment in this data development exceeds that for HELP, although the exact amount isn't known. • This is a VERY important data set for electrification GIS functions.	Complete end 1998
NER / IDT joint venture	NER / IDT	• Strengthen and update current NER and IDT databases. • Provides urgently needed facility for NER structures to allocate electrification funds. • Use in clinic and school electrification programme. • This project will seek to use selected HELP data by purchasing the rights from Eskom. • Will probably need integration with Eskom work for effective allocation of national investment in GIS data.	
Project *"MERGE"*	South African Surveyor General	• To GIS code South Africa's cadastral information. Relevant to electrification but project EAGLE probably more useful for the same application.	Complete mid 1998
Project "MIRACLE"	Mowbray Map Office	• GIS code South Africa's 1:50 000 series of topographical maps Would be relevant to electrification in terms of more sophisticated costing of grid extension and reticulation.	Complete mid 1998
DBSA / EDRC electrification criteria project	DBSA	• A detailed project to examine how criteria should be applied to electrification policy development, electrification resource allocation, project selection and technology selection. • Although this is not a GIS data development project it is a key input in the area because it looks at how GIS data might be used.	Complete mid 1998

Data/GIS projects of potential use or potential future use to electrification

Project / database			Complete
EDRC/DME National Energy Use Database	DME	• Contains extensive references to energy surveys and studies of household energy use.	Complete
Digitised satellite images	CSIR	• Possible usage for change detection	
DWAF water supply databases	DWAF	• Extensive data	Complete
CSIR databases		• Radiation – could be of use to indicate areas where SHS systems would be viable. But this is probably just about everywhere in South Africa.	Complete
More CSIR databases[5]		• Wind • Biomass • Physical access[6]	Complete some areas
More CSIR databases[7]		• Department of Housing housing projects databases • Integrated Development Information System – project at concept design stage but may be very useful to electrification • Integrated Development Planning (IDP) databases – 27 pilot IDP's are being carried out. See Green Paper on local government. May be useful in future to electrification. • Spatial Development Initiative (SDI) databases.	For some projects Concept Pilot – samples Some examples available
Telkom database		• Could be of use[8]	
HSRC database	HSRC	• Could be of use	

[5] Probably of marginal utility to electrification in the medium term at least.

[6] Data indicating the physical accessibility of an area based on transport infrastructure, distances, terrain

[7] These are either still in design phase or are limited to specific regions (SDI's) or localities (IDP) databases.

[8] The use and contents of these was not ascertained in the study.

It is clear from the long list of databases in the tables above that there are many parties involved in terms of GIS data relevant to electrification. It is useful to list these parties with their main roles / functions as a component of the background.

Party	**Role / function**
Department of Minerals and Energy	Electrification Policy Establish electrification planning methods, criteria Leadership on GIS – database requirements, standards
Eskom	Electrification policy maker (de facto) Electrification funder Electrification planning Electrification implementation Database developer
National Electricity Regulator	Electrification policy maker (de facto) Electrification planning Supervise electrification implementation by local authorities Database developer
External Electrification Funding Evaluation Committee	Allocates funds for LA distributor electrification projects. Members: NER, Eskom, AMEU, Department of Housing, DBSA, Department of Constitutional Development, IDT, SALGA.
DBSA	Input to Electrification Policy Electrification funder Input to decision making on allocation of electrification funds Development co-ordination
CSIR	Input to electrification policy Database developer Database Services Development co-ordination
IDT	Database developer Database services Schools and Clinics electrification implementation

Table con't	
Party	**Role / function**
Local authorities	Electrification funders' Electrification implementers
AMEU	Co-ordinate local authority electricity department interests

Background – institutional issues

The table above listing current GIS electrification databases and database projects shows that considerable investment has been made in GIS databases and that large projects are currently underway in the area. What is apparent is that institutions, who in an ideal situation should be developing data and systems jointly, are in fact implementing their own initiatives. In some cases, different divisions of the same institution are implementing projects in a manner which may either lead to duplication of work or which may require complicated arrangements for data sharing or common approaches to data access and maintenance in the future.

The most relevant examples of the above are the following projects which would ideally be implemented jointly:

- Further development and maintenance of the Eskom HELP database
- The NER /IDT database
- Eskom / CSIR South African renewable resource database
- Project EAGLE
- Digitisation of the Eskom HV / MV network
- The DBSA / EDRC electrification criteria project

While there is a degree of co-ordination of this work through, for example, common membership of management and co-ordinating structures (such as project steering committees) there is evidence of a significant divergence and lack of adequate co-ordination at the institutional level.

Background – summary

Two clear conclusions emerge from the background presented above.

Firstly, that the South Africa electrification programme is an important social investment representing a considerable expenditure and there is a need for improvements in terms of development and implementation of more rational planning methods. Development of GIS-data, specifically large data sets describing the situation of households/houses and current electricity supply, would be an important and necessary input to this improved approach.

Secondly, the need for this GIS data has already been recognised and responded to. Large data sets have been developed and a number of projects are currently being implemented to use these, expand them and develop new data.

Thirdly, at an institutional level, there are strong indications that data development, access and maintenance are enjoying a low level of co-operation that hampers optimal utility.

Requirements of an electrification GIS: system, data, institutional

GIS system requirements

It is sometimes rather pointless to attempt to describe something in words when a simple demonstration would save a thousand words and do a far better job. If the reader has not observed GIS systems in operation it is recommended that the best way to understand their immense power is to attend a demonstration.

Thus, this section does not attempt to describe GIS systems in a way that only a live demonstration could do. Instead, a brief consideration of GIS system functions, as applied to the electrification GIS uses that have been identified is presented. This is done with a view to supporting the conclusion, agreed by all parties interviewed that current commercially available GIS systems include all the functionality necessary to provide electrification policy, planning and fund allocation requirements.

Six uses for an electrification GIS have been identified namely:

1. Electrification policy
2. Allocation of funds: provincial level
3. Allocation of funds: local distributor
4. Long term planning: grid / off grid
5. Integrated development planning
6. Support for implementation

These uses require the following functions from the GIS. The functions would be applied in an integrated way in fulfilling the uses listed above.

Selection functions

This function would allow various criteria to be applied in order to make an input to selection of electrification projects. When linked to the other functions below the selection function would be used in policy development by testing the application of various criteria in terms of the effects on, for example, costs or number of connections. It would be used in planning or cost allocation by using an agreed set of criteria, developed as described above, to select projects.

Costing functions

This function involves the calculation of extending the grid and reticulation and can be provided by the GIS. One of the important powers of the GIS is the use of costing in conjunction with selection and grid extension planning functions.

A good example of the use of costing would be comparative costing of grid connection compared with an off-grid solar home system.

Grid extension planning functions

The GIS can be used to calculate various options for planning the route and sequence for extending the grid. This can then, for example, be combined with data describing potential consumers that

could be connected with various extension scenarios to provide estimates of costs, revenues and demand.

Linking of spatial information functions

The linking of a number of data sets by means of their spatial relationships is the key advantage offered by GIS's over other data storage and display methods. This allows complex combinations of data to be used to provide, for example, sophisticated selection functions. For example, if the required data has been GIS encoded one could easily include all of the following data in comparative selection of electrification projects:

- The position of the existing grid and planned grid extensions
- Integrated development information (i.e. planned development projects, service centres)
- Spatial Development Initiative Areas (special projects in a development corridor)
- Economic - GGP, incomes levels, employment, economic activities
- Demographic data
- Other services (water, transport, telecommunications)

Commercially available GIS systems

This is not an issue or a problem.

Data requirements

The scoping study follows the approach of considering three phases in the development of methods and systems of applying GISs to electrification. This overcomes the problem of having to decide or agree on ALL the data that will be required for implementation of an electrification GIS. Instead, the data required for the various phases is identified and then the question is answered whether existing data, or data currently under development or planned for development will satisfy the requirements.

Phase 1 – Introductory / promotion phase

The introductory / promotion phase needs to satisfy two GIS use areas

Firstly, to demonstrate the use of GISs in electrification to promote their adoption and dissemination and to provide resources for experimentation so that the knowledge on GISs can be built. Problems can be identified and additional requirements clarified. This will include the development of agreement on electrification criteria (see Banks and Thom: 1998).

Secondly, there are immediate requirements in terms of electrification policy development, allocation of funds, electrification project selection and electrification planning that is currently underway. Phase 1 one seek to begin the introduction of electrification GISs into these existing processes.

During the introductory / promotion phase very basic criteria will be applied in very simple methodologies and only basic data will be required. The purpose of this phase will be to introduce the concept of using GISs in electrification and to demonstrate their utility.

Phase 2 – Intermediate phase

The intermediate phase will involve more formal adoption of GIS in electrification. This would probably involve the integration of the Eskom and NER fund allocation and project selection processes and the also the first steps of integration of off grid planning with grid planning.

During the intermediate phase more sophisticated criteria will be applied and thus additional data sets and more complex methodologies for application of the criteria will be required.

Phase 3 – Further development

The experience gained in the previous phases will inform this phase. The phase is included explicitly as recognition that at present it would not be productive or necessary to attempt to plan phase 3 in too much detail before the requisite knowledge and experience has been gained.

Detailed check list of uses of electrification GIS, data requirements and data status

Banks (1998) identifies many variables currently considered in electrification projects. It is very important, in considering electrification GIS uses to differentiate between the large amounts of data and information that is used by the time an electrification project has been completed and the much smaller data set data that is appropriate to the potential uses for an electrification GIS. Much of the detailed data is only required from the design phase of projects onwards. Also, the inherent inaccuracies of data in a national GIS, which cannot realistically be updated in real time, means that a realistic limit needs to be placed on what can actually be done using GIS.

An important conclusion of the study has been that data required for phases 1 and 2 above already exist or are under development and will soon exist[9]. The section below is has been included to indicate how this conclusion has been arrived at by answering the following questions in a systematic way:

For each of the six electrification GIS uses identified:

- *Question 1: How would the electrification GIS be used?*
- *Question 2: What data would be required?*
- *Question 3: Does existing or soon to be existing data satisfy the requirements?*

The questions are answered below for phase 1 and phase 2.

The table below is a summarised presentation of data requirements and data status. The table should be read in conjunction with the explanatory sections that follow.

[9] The word "exist" here is used meant to mean that the data is present in a GIS compatible form on a database. It should specifically understood that this does not mean that the data is available or accessible for electrification purposes. For example the owner of the data may not want to grant access to the data except under certain conditions. "Existence" is a necessary but not nearly sufficient condition for the data.

Key

Data set needed	n
Data set not needed	-
Data set exists	e
Data set will exist soon	s
Data set doesn't exist	x
Data set would be useful but not essential	u
Status of data uncertain	?

USE	1. Electrification policy	2. Allocation of funds: provincial level	3. Allocation of funds: local distributor	4. Long term planning: grid / off grid	5. Integrated development planning	6. Support for implementation
Data set : Introductory / promotion phase						
Houses / EA's	ne	ne	ne	ne	ne	-e
Electrification status	ne	ne	ne	ne	ne	-e
Electricity HV/MV grid	ns	ns	ns	ns	ns	-s
Costing: reticulation/connection	ne	ne	ne	ne	ne	-e
Costing: grid extension	ns	ns	ns	ns	ns	-s
Topographic data	ns	ns	ns	ns	ns	-s
Additional data set - intermediate phase						
Household income	ne	ne	ne	ne	ne	ne
Wealth indicators	ne	ne	ne	ne	ne	ne
GGP	ne	ne	-	-	-	-
Solar radiation resource	ne	ne	-	ne	ne	ne
Wind resources	-	-	-	-	-	-
Biomass resource	ne	ne	-	-	-	-
Dept of constitutional development IDP	-	-	-	-	-	-
DWAF water	-	-	-	-	ne	-
Economic development projects	-	-	ne	-	ne	-
Department of housing housing projects	ne	ne	ne	ne	ne	ne
Spatial Development Initiative databases	ne	ne	-	-	ne	-
HSRC						
South Africa National Energy Use database		-	-	-	ne	-
Eskom Omni-Panel survey	ne	ne	ne	-	-	ne
IDT database	ne	ne	ne	ne	ne	ne

Data requirements for GIS development phases

Phase 1 Introductory / promotion phase

Note

To illustrate how the table above works an example of how questions 2 and 3 above have been answered is presented below.

Use: 1. Electrification policy

The GIS will be used for estimating the results, in terms of numbers of connections and costs and areas and categories in which connections will be made if different electrification policies and strategies are followed. For example, the GIS could be used to run an algorithm which would explore a policy option in which the next houses to be electrified would be those that could be connected at least cost.

Data requirements would be:

- The electricity grid in GIS format. [The HV/MV grid is currently being entered onto GIS by Eskom].

- Either individual houses, or housing densities at say, EA level.
  [The HELP database, augmented by project EAGLE, will provide this to adequate level of detail].

- Costing data for LV extension, reticulation and connection.
  [This can be developed relatively easily].

- GIS data on topography translated into data which would indicate HV/MV grid construction costs.
  [Project MIRACLE will provide 1:50 000 topographic maps. This can be combined with the costing data mentioned above to estimate grid extension costs.]
  (Note that because an expert system which was capable of planning grid topograhpy and complete plant requirements (transformers, swithching equipment, loads) entirely on its own would be out of the scale of complexity required operator work would be required in feeding in various grid extension scenarios)

- Question 1, namely *"How would the electrification GIS be used?"* is then answered for each of the six electrification GIS uses which have been identified in the table.

For the remainder of the uses only question 1 is answered. The answers to questions 2 and 3 are presented in summary form in the table.

Use 2: Allocation of funds: provincial level

Thom's report, titled "Criteria for the allocation of electrification resources to regions or provinces deals extensively with this GIS use.

She reports that currently the criteria being used are:

Development Bank of Southern Africa

- Economic potential

- Poverty

National Electricity Regulator

- % houses without electricity
- Poverty / development index calculated by DBSA

Eskom

(Eskom essentially attempts to achieve set connection target numbers in specific areas as cost effectively as possible).

- Connections that can be made
- Cost per connection
- Political demand for electrification

Her main conclusions in terms of the criteria that should be used in future are:

- A small number of primary criteria should be used
- A mechanistic application of the primary criteria will not produce the best result. The output of the mechanistic process needs to used as an input to an allocation process involving discussion of other factors which are not possible to merely assign to an index or number.

An important point raised by Thom is that there are opposing imperatives for the electrification programme. The main tension is between supporting economic growth on the one hand and addressing inequality in provision of social services on the other. She thus suggests using separate sets of criteria for two different types of electrification namely:

Electrification in support of economic growth

- economic potential of region
- actual projects in each region where electrification will support commercial production and job creation

Electrification in support of socio-economic development, electrification backlogs

- Share of un-electrified households / population in each region
- Share of un-electrified administrative and service centres

To properly implement the criteria suggested by Thom data sets including all projects supporting economic development would be required. For example, the electrification resource allocated to a region would depend on the number and size of other development projects planned, both social and economic. Currently, these projects have not all been entered onto a GIS database, and there is no known single initiative undertaking this. Thus, if this data-set was used in phase 1 provinces which in fact had development projects but these were not on the database would be penalised.

The problems caused by lack of a single GIS database with all development projects is illustrated by the problem posed here. Not only electricity development projects but development in all sectors would be much more successful if the individual initiatives could at least be made aware of each other through a central information system The Integrated Development Information System which has been proposed by CSIR (amongst others) attempts to solve this problem.

In phase 1 considerable improvements are possible in current provincial allocation methods by just improving existing allocation by using electrification GIS with the limited number of data sets indicated in the table.

Phase 2 Intermediate phase

All data sets needed for introductory / promotion phase are needed for intermediate phase. Thus the section below just identifies additional functionality associated with each use in the intermediate phase.

Extend estimation to include some extra criteria for example, plans for other development (such as industry, SDI's, agricultural projects) which would be used to prioritise certain electrification projects.

See table above for a summary of phase 2 data requirements.

Aspects related to data quality

Data for different areas is often of very varying quality. While it is out if the scope of the study to assess all the data there is agreement that the data, as long as it not used to design level, is sufficiently adequate for the six uses.

It is not feasible to audit all the data in terms of quality. This would be tantamount to re-capturing and coding it. The information community concept in the proposal would deal with data quality aspects in two ways:

- In shared use of data, users who identify inaccurate data could flag the data according to accuracy problems.
- Users could communicate with the data services provider indicating proposed new values. This would often need verification methods.

Summary of data requirements

Phase 1 – basic data

- The electricity grid in GIS format
- Either individual houses, or housing densities at say, EA level.
- Electrification status (i.e. connected or not or % connected)
- GIS data on topography translated into data which would indicate grid construction costs.

Phase 2 – data for intermediate phase

See table above for a summary of phase 2 data requirements.

Requirements - institutional arrangements

The institutional history and current situation around GIS development has been summarised in the *Background* section above. The situation is far from optimal in that different institutions, and in fact different divisions in institutions, are taking their own paths in terms of GIS development and usage despite the fact that they are involved in exactly the same activity, namely the national electrification programme.

To attempt to examine options for the proposal in section 3 the following requirements have been identified in terms of electrification GISs as far as institutional arrangements are concerned.

Access to data for GIS

Access in this context specifically does not mean ownership. It simply means adequate access to use the data in GIS and other computerised systems. This could, for example, be via CD-ROMs or the Internet.

A very simple but basic requirement for a South African electrification GIS database is that the major institutions responsible for the six GIS functions identified above should all have access to a basic common platform of data. This data should include the data identified as "basic GIS data" for the introductory phase described above namely:

- The HV / MV electricity grid in GIS format
- Either individual houses, or housing densities at say, EA level.
- Electrification status (i.e. connected or not or % connected per EA)
- GIS data on topography translated into data which would indicate grid construction costs.

After the introductory phase access to additional data sets will be required as allocation and project and technology selection criteria become more sophisticated.

Location of data

Requirements in terms of institutional arrangements are as follows:

- the physical or institution location is not an important issue
- all data does not have to be in one place

Data maintenance

Data maintenance is an extremely important issue. The situation on the ground is changing very rapidly. It is too costly and South Africa does not have the resources to re-survey the entire country and re-build the databases every year or two. This is also impractical because in many cases it takes years to code and process data to prepare it for typical GIS uses. If one considers the possibility of each institution duplicating the effort for their own copy or version of a large database this is clearly not a viable option.

Thus, the only feasible alternative is effective co-operation on data maintenance. This would happen on four levels:

- Mechanisms and facilities should be put in place so that institutions involved in actually changing the physical situation, e.g. electricity distributors making new connections, can forward data on these for entry to the database.

- Periodical large re-surveys need to jointly planned and funded. An example is the census for which CSS takes responsibility.

- Mechanisms and facilities should be put in place so that institutions that collect or verify data on the ground forward data on this for entry to the database. A typical example would be that an electricity distributor identifies a settlement as a possibility for electrification and on the basis of this carries out a detailed study on the ground. Many hundreds or thousands of such studies (if one includes water projects, agricultural projects etc.) are done each year.

- Where major lacks or gaps in data are identified by the main electrification GIS users, mechanisms need to be put in place to agree on this and jointly fund data development.

To implement these levels it is important to consider a number of factors. The two most important are funding and institution roles and competencies which are dealt with below.

Data versions

An aspect that links location of data and data maintenance is *data versions*. It is important, for a number of reasons, that one master version of a data set is acknowledged. Depending on the usage of a database there are many ways to manage this. However, for the electrification GIS database, the only feasible way would be for each data sub-set to have a clear "responsible institution" at any one time. This responsible institution would ensure the integrity of the master copy. This would include managing updates to the copy.

Financial aspects

At least R15 million has been spent by Eskom on the HELP database and Eskom is also expending further tens of millions of Rands on GIS-coding the HV / MV network. This represents the major expenditure on electrification-specific GIS to date.

Much larger amounts have been spent on general purpose data such as the Census, Cadastral Survey, GIS-coding the topographic maps etc.

There are two central questions around financial aspects of the electrification GIS:

1. Should there be some recovery of the investment made to date in terms of recovering this by charging for access to users outside the institutions that made the investment? If so how should this be arranged?

2. How should maintenance and future development of GIS databases for electrification be funded?

When interviewing the main parties involved this was the area in which opinions appeared to be most divergent. It is probably also the issue most responsible for delaying data access and maintenance arrangements which involve all parties and which is necessary for development and integration of GIS-powered policy development, planning and implementation.

Some answers to the funding question do appear to be emerging and its is believed that this process will not be supported if a position is taken in this study so the questions will be left open. However, a useful contribution, in terms of moving towards consensus on a project proposal, may be the following comments on possible institutional roles.

Government as funder

Ideally, public funds should be made available to fund data development and access that is required by the public, civil society, and public institutions to serve the national interest. However, effective funding means that government has to have the mechanisms and capacity to identify data requirements and act on these sufficiently promptly to provide the data and data services in time.

Historically, the government department responsible for electrification, namely the DME, has left this function up to Eskom. The National Electricity Regulator and IDT have also taken responsibility for funding GIS development in the areas of the electrification programme they are responsible for. The DBSA, as the major electrification banker has taken much responsibility for development of regional allocation and project assessment and selection criteria.

If one looks from the perspective of each of the main institutional players (Eskom, NER, DBSA, IDT, local authorities) it is easy to agree with each that it is difficult for them to motivate why they should fund GIS data development which will then be used by all. Knowing the very different institutional characteristics of these institutions, and being aware of the impossible-to-answer question of "*what proportion of data costs should each party contribute in a joint development* ?", it is also easy to agree that joint data development is highly problematic.

The following facts are also relevant in considering government's responsibility in terms of funding this data:

- There is general agreement that a GIS with data to support the six electrification uses identified in this report on a national integrated basis would make significant improvements to the electrification programme both in terms of efficiency and economic effectiveness.

  The 1996/97 electrification programme involved investment of more than R 1 200 million. Each 10% improvement in either efficiency or effectiveness would lead to an increase of R120 million in the benefits of the programme.

- There is general agreement that a large component of the electrification programme, namely SHS/off-grid is more or less at a complete standstill because of the lack of an effective plan. There is also agreement that the most effective way to develop such a plan would require an electrification GIS used within an integrated electrification programme.

In the light of the above it would appear that government investment of some tens of millions of Rands would be completely justifiable even if the total improvement were only of the order of 10%.

DBSA as funder

The DBSA has disbursed a total of R 2 900 million on electrification (Banks 1998) and has, as such become a major electrification banker. This has been done via the main electrification role players such as Eskom and National Electricity Regulator and also directly to local authorities and other parties.

In the absence of government being able to take the lead in facilitating development and access to necessary data the DBSA has an important interest in the existence and use of adequate information to ensure proper performance of its electrification investments.

Users as funders

The main users are the agencies responsible for allocation of electrification funds and implementing electrification planning. The largest, Eskom, has funded and is funding GIS data development for its own use. NER / IDT are involved in a joint venture to develop an electrification GIS. Thus the users have funded the GIS development. However, the problem with users funding GIS without appropriate co-ordination functions is exemplified in the fact that separate databases are being developed which would seem to be a far from optimal solution given the limited resources and common needs.

Issues related to roles and competencies

The following advantages, disadvantages, and practicability factors are seen as relevant for the various institutions that may be involved in GIS development, access provision and maintenance.

Government statistics agency

- Ideally CSS should fund and own this type of national interest public access data. CSS has other priorities at the moment over the transformation period and thus some time may be required before CSS can take this role.

- However, CSS is providing important electrification data and currently managing and facilitating access to very important electrification GIS data. Examples are project MERGE EAs and the linking of household census data to EAs

- CSS is using Megasub Pty Ltd (i.e. specialist private sector company for services to development data). This shows a recognition of the utility of outsourcing data services.

- It is currently not a feasible option in South Africa to get CSS to take responsibility for specialist electrification data such as GIS capture and coding of electricity grid.

- Also, CSS probably not in a position for next few years at least to provide state of the art access services to data.

- The GIS coding of the Cadastral Survey (project MERGE) and topographic map series (project MIRACLE) are also examples of huge successful government investment in data required in the national interest.

- Because MOST (JUST ABOUT ALL) of the data that is required by the electrification GIS will in fact also be very useful to other development agencies and economic planning functions the rationale for the data to be held solely in the electrification sector is virtually non-existent.

- Access by other economic sectors and as wide a variety of institutions to the electrification GIS data will add significant value to the data – as opposed to the idea that providing access represents a cost.

Conclusions

- CSS to provide certain data currently developed and maintained by CSS (e.g. census, EAs, etc.) and ideally, over the coming years, electrification data and other development data to be handed into CSS management as CSS capacity becomes available.

- Ideally, CSS also to fund development, maintenance and access to data used for national interest planning, such as electrification GIS.

Data services agency

Both Eskom and CSS currently use a data services agency, namely Megasub Pty Ltd, to develop data maintain data and provide access to this data.

Eskom and CSS have recognised that this is an efficient and effective arrangement.

There is a concern that data service agencies who undertake this type of service arround national interest data that should ideally be in the public domain should not use their position to become significant data owners. This would possibly represent a conflict of interests.

Conclusions:

- Data services agencies to be used in a cost effective transparent manner – e.g. renewable contracts based on open tender.

- Data service agencies should be kept at arms length from data ownership and contracts with data service agencies should deal with this area meticulously.

Government electrification agency(examples Eskom, National Electricity Regulator)

- The electrification agencies are the main (but not sole) users of the data and thus the electrification agency is probably best placed to specify data required and how it can be used.

- However, Eskom experience is that for data-sets the size of what is required for the national electrification database, institutions outside Eskom, specialising in data services, should be used for GIS data development, access provision and maintenance.

- Funding and ownership of the data has been problematic. Solely for pragmatic reasons the electrification agencies have funded data development and are now the *de facto* owners. On the plus side at least the data has been developed. On the minus, there are now a number of hurdles to overcome in terms of negotiating for access and future maintenance of the data.

Conclusions:

- Electrification agencies should specify data requirements

- Existing data owned by electrification agencies should be transferred into public domain with due regard for history, institutional relationships, rights of ownership and future needs around data development, maintenance and access. Necessary funding should be arranged for cost recovery and should not penalise achievements to date or provide disincentives for successful ongoing efforts.

Government development funding agency

- The R 2 900 million investment by DBSA in electrification is an example of the role played by such an agency. IDT's role in clinic electrification is another example

- The development funding agencies have the main institutional role of identifying social and economic investment to support development. In order to do this they have some similar needs as the electrification agencies. They are thus in a good position to specify data requirements.

- There are opinions to support the view that because the development funding agencies need access to data which does not exist that they should fund its development. However, many other government agencies are also making large investment and need the same or similar data. Thus the opinion that a single development agency should fund development of data sets which others need runs into the problems that have been the major obstacle to development of ONE national electrification GIS namely:

    - If the development agency funds the entire development how does it recover costs?

    - How does it co-operate with other agencies in specifying the data?

    - How is access facilitated: technical services, resources, charging?

The problems of the example of individual agencies funding their own databases has already been demonstrated in the separate Eskom and National Electricity Regulator databases.

Conclusions:

- Because of the size of existing DBSA investment in electrification and planned future investments, DBSA should take steps to ensure that a means is found to provide the electrification GIS that can support further effective efficient electrification investment as a matter of priority, if only to protect DBSA investment.

- Recognition needs to be given that a transitional phase may be required to normalise the situation and that government departments such as DME and CSS will probably not be in a position to achieve the results that DBSA urgently requires in terms of the electrification GIS.

Comments on some possible solutions

The project proposal chopping block in Part 3 proposes a specific solution to the way forward for providing a GIS for South Africa electrification. In making this choice a number of solutions are possible.

There are two poles with a number of solutions in between them.

1. At the one pole CSS or central development agency takes responsibility for identifying electrification GIS data requirements and develops and integrates these with other development GIS databases.

2. At the other pole private sector takes responsibility and sells data access – this implies full commercial data ownership and provision.

Between these poles there are a number of hybrid solutions with a mixture of responsibilities between a central state data agency, parastatals, other statutory institutions and the private sector.

Some potential mixes include:

- State development data agency takes responsibility on clear specification developed by major agencies (Eskom, DBSA, IDT, NER).

- Major agencies (Eskom, DBSA, IDT, NER) put together consensus position specifying project for DME to fund and manage.

- Informal electrification information community trades data and services on basis of their current data assets, needs and expertise.

- Electrification information community in IDIS framework.

- Major agencies (Eskom, DBSA, IDT, NER, CSIR) run joint project. Minimum private sector involvement although some work may be out-sourced

- Major agencies (Eskom, DBSA, IDT, NER, CSIR) commission joint project. Contract private sector company to provide all data services.

- Single agency (eg Eskom or DBSA) commission joint project except limit this to managing own investments. Contract private sector company to provide all data services. (This is de facto situation with HELP).

Part 3

Project proposal for GIS for electrification

Conclusions from scoping study on which the proposal is based

This project proposal is presented as a *"chopping block"* based on the following main conclusions of the scoping study:

- Commercially available GIS technology is mature enough to offer off-the-shelf systems capable of supplying functions for electrification. While some standardisation is required this is thus not a major area for the project.

- Significant resources of the order of between R15million and R30million have been spent specifically on developing GIS demand side data for electrification purposes. Even larger amounts are being invested in supply side data by GIS coding the HV / MV network. Far larger amounts have also been expended on development of other data relevant to electrification such as household census information and GIS coding the enumerator areas. The existence[10] of data is not seen to be problematic. It is most often not a case of making resources available for further data development but more a problem of how to make this data accessible and to ensure that it is kept current. Both these areas require a variety of institutional capacities for effective solution.

- It must be noted that there are concerns about the variability of data quality. However, this does not seen to have major negative implications for adequate servicing of the six electrification uses which have been identified. The quality problems do not imply a major data re-development requirement but rather a requirement for sensitivity on the part of users to work around the problem and effective methods to flag and update the data. Also, because of the rapidly changing terrain (e.g. mass housing development – formal and informal, population movement etc.) the data will in any case never reflect the situation on the ground exactly. Methods of use of the data will always need to be robust in this respect.

- To date the largest relevant institutions (CSS, Eskom, NER, IDT, CSIR, DME, Department of Housing) have not reached agreement on a common or joint or coordinated project for electrification GIS. In fact, the largest organisations are executing or initiating separate projects. There is co-operation as far as these projects are concerned but they are not being planned or implemented jointly by the largest organisations. In some cases joint ventures involving two of these institutions (Eskom & CSIR, Eskom and Department of Housing, NER & IDT) have either been attempted or are about to be attempted. In general, past joint projects have been problematic.

- There appears to be general agreement among most of the above institutions that a process to agree on a joint venture involving all parties will most likely be protracted and not necessarily produce useful results. Some other form of creative approach will be required to provide the

[10] The word "exist" here is used meant to mean that the data is present in a GIS compatible form on a database. It should specifically understood that this does not mean that the data is available or accessible for electrification purposes. "Existence" is a necessary but not nearly sufficient condition for the data.

electrification programme with the GIS it requires. However, there are signs that these parties are starting to co operate even if solely motivated by the sheer impracticality of duplicating data development and maintenance resources.

- There seemed to be general agreement that a main driver of choice for future development of electrification GIS data would be financial considerations in terms of payment for data access, maintenance and development.

- An additional financial consideration is the ownership of existing data assets. A breakthrough in this area would have extremely positive implications for future potential for co operative projects.

- CSS and Department of Minerals and Energy capacity at present precludes their taking responsibility for the electrification database in the short term.

Summary of the proposal

The scoping study has identified the existence of a community of professionals and organisations that are already carrying out electrification GIS work. However, largely owing to arrangements out of the control of this community there is a lack of institutional co-ordination. Although some institutions are managing to develop and use GIS's for electrification the lack of co-ordination is seriously hampering efficiency and progress in the work.

The immediate and apparently obvious answer would be to pull the various activities into one co-ordinated effort. However, the current institutional set-up is not amenable to this. An important conclusion of the scoping study is that "*a process to agree on a joint venture involving all parties will most likely be protracted and not necessarily produce useful results*".

It is thus recognised that to get from a stage where multiple databases, projects and organisations are implementing separate electrification GIS projects to a more co-ordinated set-up a transitional phase is required.

Thus, the project proposal takes an approach whereby the first phase of the project seeks to build the existing community by recognising the community and providing support to it. Also, resources are provided for the community to strengthen itself and build common ideas and ground for a future phase where a more formally co-ordinated project can establish and maintain an *Electrification GIS Common Platform*.

In short, the project proposal is divided into two phases, namely:

Phase A – Promotion of the Electrification GIS Information Community

Phase B – Establishment of an Electrification GIS Common Platform

Details of these two phases are now presented.

Phase A – Promotion of the electrification GIS Information Community

This phase is concerned with carrying out activities and providing resources to build and support the community.

Sub-project 1: DEMONSTRATION

The sub-project will demonstrate the use of rational planning approaches and GIS in electrification. The exercise outputs will be generated by means of a scenario type activity. Existing GIS data and systems will be used in a selection of potential electrification GIS functions and the results compared. This will demonstrate the use and benefits of GIS in electrification.

The objectives are to:

- Run example electrification GIS exercises that produce outputs that can be used to demonstrate benefits that would result from the approach. In particular, the following quantified estimates would make a strong case to drive further use of GIS.
  - Savings owing to efficiency improvements
  - Better effectiveness in terms of supporting development and social objectives
  - Better information for estimating and comparing costs and revenues for electrification projects
- Publicise the practicalities and requirements of the approach to relevant institutions and individuals
- Identify problems and requirement in practice.
- Identify existing examples of GIS application that have already been carried out in South Africa and publicise these. For example GIS systems have already been used in the Eastern Cape by Eskom.

In terms of sequencing, the sub-project 1 would be timed to provide material for input into sub-project 2.

Sub-project 1 – details of outputs, activities and resources required

Activities **[Time frames]**	**Outputs**	**Ball park resource estimates**
Run example electrification GIS exercises Research and prepare other examples from South Africa [2nd half 1998]	1. Description of electrification GIS uses and methods 2. Examples of a selection of main uses. Outputs include reports and hands-on demonstrations aimed at key audiences such as representatives on bodies such as the *External Electrification Funding Evaluation Committee* 3. Description of other experiences tailored for activity below	60 person-days: - GIS experts - Modellers - Electrification planners Access to basic phase 1 data sets Access to GIS systems and GIS experts
Publicise results	1. Workshops / seminars 2. Hands-on demonstrations	30 person days – people from the teams above
Assess results	1. Research assessment of capabilities, limitations and additional needs	20 person days – people from the teams above – external assessor

Sub-project 2: Consolidate and promote the electrification GIS Information Community

This sub-project recognises that a community already exists spread across many organisations but which is aware of itself and already co-operating to some extent. Objectives are to:

- Develop and strengthen the concept of the electrification GIS community. This would involve describing the community in terms of its members, roles, assets, expertise and needs and facilitating communication between members.

- Get support for development of the community. This would include support from key individuals and institutions.

- Build convergence of ideas in the community. This will not attempt to impose ideas but will facilitate the development of common ground and goals in the community and facilitate co-operative activities.

- Publicise the community and its shared data to other communities.
  For example, if development projects other than the electrification projects were made aware that they would stand a greater chance of receiving electricity as a result of posting their information on the shared database one may soon find all prospective development projects that needed

electricity posted on the electrification community shared databases.
Another example would be to publicise the community and its assets and expertise to state data agencies.

- Provide services and facilities to support and extend the functioning of the electrification GIS information community.

Sub-project 2 – details of outputs, activities and resources required

Activities **[Time frames]**	**Outputs**	**Ball park resource estimates**
Workshops for community to define roles, assets, expertise and needs and options for development [2nd half of 1998]	1. Papers describing the community 2. Paper detailing options for way forward	1 or 2 days for each member 10 days for facilitators to prepare workshop and material
Workshops to examine outputs from phase 1 and to decide on way forward Development of papers	1. Short papers on electrification GIS uses, database assets and database requirements based on outputs of sub-project 1 2. Document describing way forward 3. Document detailing options for supporting facilities, services and web-site	1 or 2 days per member 10 days for facilitators 15 days for reports, papers
Write report based on information and experience from sub-projects 1 and 2	1. Report on options and potential plans for supporting facilities, services and web-site	10 person-days
Management of projects	1. Detailed planning of activities 2. Decisions based on progress	On-going steering committee from key institutions

<u>Promotion campaign for information community and common data platform</u>

- Confirm support of key individuals and then specifically engage additional key individuals to attain critical mass of support.

- Produce information materials, presentations, seminars
Build a common understanding of crucial ideas relevant to data development, maintenance, data sharing and concepts related to data value and data system costs for the electrification GIS.

- Publish information on existence[11] of data relevant to electrification
- Disseminate electrification information community concepts in relevant publications. Before establishment of the web site this will be the primary mode of publicising the community.
- Support process that is already underway to promote sharing of data access and sharing of data costs. Promote idea of development of common data platform.
- Provide technical services as follows:

  a. Translate / transform some public data sets to common GIS standards

  b. Training on GIS to build and spread critical level of knowledge and skills

Activities **[Time frames]**	**Outputs**	**Ball park resource estimates**
On-going support to steering committee to achieve objectives above	1. Appropriate material for dissemination and publicity	20 person-days
Design and implement web-site	1. Functioning web-site fulfilling objectives below	20 person-days – site designer – people involved in projects above Copies of databases Web server facility
Provide technical services as specified above		40 person-days access to GIS systems and data

[11] See usage of word existence in terms of data sets in previous footnote.

Web site

A web sites provide an effective community building and maintenance facility with which many members of the community will already be familiar. It provides a highly cost effective tool for information and data sharing, exchange of views, debate and co-ordination of activities and technical support.

Develop and run a web-site to do the following:

- Consolidate the already loosely existing electrification GIS information community.
- Promote the information community.
- Development and promote agreement on concepts related to electrification and IDP, GIS, projects, institutions and practice.
- Publish information on data availability.
- Hold and supply databases that are already in public domain or that can be sourced at low cost. (If these are already on other sites a link can just be provided).
- Provide a forum for data developers for voluntary co-ordination / co-operation
- Provide support on GIS skills
- Provide information on electrification planning
- Hold information of examples of the use of GIS relevant to electrification. Initially these could be drawn from the outputs of the demonstration sub-project. Later, examples of actual practice could be held.

The Web site would be provided by a data service provider such as Megasub (or any other, according to an open competitive tender process) that can provide the web facilities plus the GIS functions.

PHASE B: A common GIS platform for electrification

This section of the proposal provides a proposed arrangement for providing an electrification GIS for South Africa in terms of:

- the databases;
- access arrangements,
- maintenance, and;
- funding.

Although consensus on an arrangement that would be acceptable to all the major parties involved is still at an early stage of development the proposal provides a clear choice in the spirit of providing a concrete suggestion that can be used as a chopping block.

The primary goal of instituting the common GIS platform for electrification would be to concretise the results of phase A of the project and to demonstrate and support a functioning electrification community in South Africa with a common set of resources and agreed goals. The common GIS platform would be used as the basis for integrating the South Africa electrification programme in terms of Eskom distributors, local authorities, the National Electricity Regulator the IDT and the off-grid/SHS programme.

The databases

Phase B is largely concerned with achieving the necessary level of co-operation between key electrification players. The focus will thus be on simple robust development that avoids unnecessary complications. It is more important to have all the players involved in an integrated activity in which they all take part than to resolve contentious issues involving application of complex allocation algorithms and a large number of data sets.

The databases chosen are thus those identified as the "basic GIS data" for the introductory phase described in section 2 above namely:

Data description	Database
The HV / MV electricity grid in GIS format	Eskom GIS data which Eskom says will be ready by end 1998 and will be public
Either individual houses, or housing densities at EA level	Eskom HELP database data-set** updated by project EAGLE
Electrification status (i.e. connected or not or % connected per EA)	Eskom HELP database data-set** updated by project EAGLE
GIS data on topography translated into data which would allow estimation of grid extension costs	Surveyor general 5MIRACLE project results: public. Data and calculation methods developed for electrification GIS project – needs special development for project.

** See section on institutional aspects below

Institutional arrangements for access, maintenance and funding

Access facility

The databases above would be installed at the data service provider selected to do the Web site and GIS facilities in phase A above.

Provision would be made for open public access.

Maintenance

Eskom currently has a maintenance agreement with Megasub for the HELP database. The experience to date has shown this to be an effective solution. A similar arrangement can be made for the national electrification GIS. In addition, the outputs of phase A above should result in effective arrangements for data verification and updating as an integral part of data sharing.

Funding

System facilities: access and maintenance

This is not seen to be the major funding obstacle at present

The next step would be to present this report to institutions such as Megasub and others for proposals and estimates of resources required.

The databases

The funding amounts required to place the HELP database plus EAGLE updates in the public domain is orders of magnitude larger than other resources required for phase A and B. Satisfactory resolution of this is the key to the project success and to the successful implementation of a national electrification GIS.

There has recently been significant developments in this area. Most of (all) the key been players have recognised HELP as containing THE data-sets that are required and the pointlessness of duplicating HELP development efforts has also been recognised, if not openly acknowledged. They have thus become open to ideas of contributing to HELP development costs and future maintenance requirements.

HELP cannot realistically be priced at cost. Also, provision for maintenance will be as important as covering development costs. Contributions in kind, of the types pointed out in the data sharing arrangements of an information community, mean that negotiations around contributions to data verification, and updating will be as important as negotiations of amounts for direct payment.

Appendix A – Organisations and people interviewed

Initial interviews and discussions

Initial ad hoc discussion were held with the follwoingpeople and organisations

Megasub Pty Ltd

Mr Jimmy Joubert, Managing Director, Megasub Pty Ltd

Ms Jeanne Le Roux

EDRC – Rural electrification project meeting

Ms Cecile Thom, EDRC

Mr Doug Banks, EDRC

Ms Wendy Anneke, Programme Leader

EDRC – Criteria project

Ms Cecile Thom, EDRC

Mr Doug Banks, EDRC

DBSA

Mr Deon Stassen

NER

Mr Steve Boshoff, Manager, Information Systems

Mr George van der Merwe, Manager, Electrification Planning

Interviews and discussions: round 1

Structured interviews were held with the following organisations and people

Independent Development Trust (IDT)

Mr Frank van der Velde

Council for Scientific and Industrial Research (CSIR)

Dr Louis Waldeck, Manager: Development Management Services, Boutek

Mr Andre Brits, Project Leader, Development Management Services, Boutek

Dr Bob Scholes, Environmentek

Mr Johann Maritz

National Electricity Regulator (NER)

Mr Steve Boshoff, Manager, Information Systems

Mr George van der Merwe, Manager, Electrification Planning

Eskom

Mr Dawie du Toit, Project Manager in charge of HELP database, Eskom Business Information Systems

Participants at Electrification Criteria workshop

Interviews and discussions round 2

Eskom TRI

Mr Minnesh Bipath

Eskom Business Information Systems

Mr Dawie du Toit, Project Manager in charge of HELP database, Eskom Business Information Systems

DBSA

Mr Deon Stassen

Appendix B details of the GIS data-sets, or other relevant data referred to in this report

The following table contains details of the GIS data-sets, or data relevant to GIS algorithms (e.g. data used in conjunction with GIS data sets to estimate costing of grid extensions) that are referred to in this report.

Data set name used in this report	**Details and comments**
Houses / EA's	Description. The houses / EAs data consist of GIS coded data either for individual houses or for housing densities per enumerator area (EA). Status. The HELP database (including project EAGLE additions) contains adequate data for all six GIS electrification uses. This use is mainly related to the density of the household spacing. (Note. Relatively complete data only exists for previous homeland areas but this is all that is required for the electrification GIS uses).
Electrification status	This data indicates whether houses are connected or not. The HELP database (including project EAGLE additions) contains adequate data for all six GIS electrification uses for the previous homeland areas. (Note. Relatively complete data only exists for previous homeland areas but this is all that is required for the electrification GIS uses). The NER database contains sufficient data on urban electrification status for all six GIS uses.
Electricity HV/ MV grid	Being coded by Eskom – will be made freely available subject to users acknowledging the source.
Costing: reticulation/connection	Information exists but would have to be formulated for use with electrification GIS.
Costing: grid extension	Information exists but would have to be formulated for use with electrification GIS.
Topographic data	Project MIRACLE: to be available in 1998
Household income	Comment. The primary utiility of income data would be to attempt to predict demand/consumption. However, to date this has not been successful for typical households in the South African electrification programme.
Wealth indicators	Comment. The primary utiility of wealth data would be to attempt to predict demand/consumption. However, to date this has not been successful for typical households in the South African electrification programme.
GGP	Old data available and difficult to use. However, there is a history of acceptable use at regional level
Solar radiation resource	Exists to adequate detail
Wind resources	Exists to adequate detail

Biomass resource	Probably not useable
Dept of constitutional development IDP	A number of these are being developed. However, only cover a very small proportion of total South Africa.
DWAF water	Water resource database exists – probably of adequate quality to feed into more general electrification allocation decisions. However, cannot be used as critical decision information on project selection without verification
Economic development projects	Varying data, varying standards. Could be use as an input but not as a critical selection criterion.
Department of housing projects	Also useful where they exist but not comprehensive
Spatial Development Initiative databases	Useful where they exist but very small proportion of total South Africa
HSRC	Not assessed
South Africa National Energy Use database	May be a useful input but not to base decisions on
Eskom Omni-Panel survey	Very detailed and useful input – question as to how GIS would use it has not been answered.
IDT database	Description. (I)Positions of schools and clinics. (ii) Local authority boundaries. (iii) Grid Status. Under development. In use for some areas. Comment. IDT has a large database of rural information