Electricity for rural institutions: guidelines from the IDT clinics electrification programme, 1993

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Abstract

The Independent Develop Trust (IDT) is sponsoring the electrification of rural community facilities in South Africa, through grant-funding to offset the non-economic portion of electrification costs. This is a multi-year programme, entailing both grid and Remote Area Power Supply technologies, and extensive liaison between grant-funders, electricity utilities, local government departments, community organisations and other role-players. The present report documents progress within this programme during 1993, with a focus on steps to electrify remote rural clinics using photovoltaic systems. So far, no installations have been completed, but extensive planning and preparatory work has been accomplished. The contextual and organisational difficulties of implementing such a programme are described, and elements achieved so far, which may serve as models for future extension and replication, are evaluated.

Executive Summary

Introduction

The report is about developments in the "IDT clinics electrification programme" during 1993. IDT (the Independent Development Trust) was established in 1990 with funds from the South African government and an initial 3-year mandate to assist welfare and development amongst the poorest communities in the country. Under the IDT Health and Rural Development portfolio, one of the key aims has been to upgrade facilities for rural health care. Requests for clinic upgrading were received from several regions of the country; in addition, IDT has a clinics building programme for building new facilities. In both cases, appropriate energy provision has been considered an important aspect of improving the services offered by rural clinics.

The report aims to be mainly descriptive, providing brief background and a step-by-step account of stages reached during the course of 1993. There is a focus on RAPS aspects. RAPS electrification (Remote Area Power Supply) is recognised as a vital technology option, complementing grid electrification, in remote localities which are distant from the existing rural grid, and for applications where high value is attached to a reliable electricity source. In the case of rural clinics, the primary electrical needs have been provisionally identified as vaccine refrigeration, telecommunications, and electric lighting for clinics and staff accommodation; these needs can be met more cost-effectively by solar photovoltaic (PV) systems than by grid extension in a proportion of the most isolated clinics.

The IDT clinics electrification programme is of interest to energy agencies and policy-makers not only in respect of its RAPS component (although this is the focus of the present report) but for rural electrification, energy and service provision more generally. IDT has formulated a policy for rural electrification support which centrally involves electricity utilities and national/international finance agencies and which stands alongside other streams of national debate about rural electrification — how to do it, where, using what selection criteria, up to what levels of penetration, and how to balance the costs and benefits of electricity provision versus other energy carriers, and other investments in improved rural infrastructure and services. Reflecting historical South African underdevelopment in populous rural areas (mainly those which were demarcated as "homelands"), and current political reform, these debates are still emergent.

RAPS electrification of rural community facilities, equally, is set within these emerging debates about policy, implementation and financing. But further to this, the supply infrastructure for large-scale RAPS implementation, and the procedures which are advisable to attain reliable and sustainable operation of off-grid electricity systems, are less established than in the conventional (grid) electricity distribution industry.

Some of the central themes running through this report are therefore:

1 The integration of RAPS and grid rural electrification, and hence the joint participation — in planning, financing and implementation — of several important role-players on the supply side, including grant-funding institutions (e.g. IDT), loan finance institutions (e.g. the Development Bank of Southern Africa), electricity utilities, local government service departments, the commercial RAPS supply industry, specialist RAPS consultants, state and policy planners.

2 The complexities (and variable capacity) of local and regional organisational structures which affect (a) the expression or identification of demand for electricity services, (b) the benefits which may be derived, and (c) the sustainability of such benefits (e.g. through technical maintenance and maintaining necessary complementary inputs).

3 The processes necessary for productive engagement between demand- and supply-side role-players, with particular attention to social and technical procedures for RAPS electrification.

A central question was identified as follows:

> *how to effect changes, at a highly local level, within a larger organisational and institutional framework, when the latter does not pre-exist*

This question is probably characteristic of many rural development challenges in developing countries, as well as having an acutely South African flavour at the present time. Practical outcomes (which may be observed in the course of the clinics electrification programme, over 1993) include the fact that new support structures and institutional frameworks have to be developed as *part of such a programme*, slowing down an ambitious undertaking; and that a coherent nation-wide approach is constrained by regional variations in capacity to move forwards.

Summary of stages of progress

The report proceeds chronologically, but for brevity this executive summary instead highlights issues rather than the sequence of events during 1993. It is useful, however, to indicate when some of the main stages were achieved:

- 1991-1992: Some 380 requests for clinic upgrading received by IDT. EDRC (Energy for Development Research Centre) prepares preliminary analysis of energy supply options. EDRC consultant visits several departments of health and public works, Eskom and other utilities to convey information and investigate local institutional and technical capacity for electrifying clinics.
- September 1992: IDT establishes a clinic building team and allocates R86 million for building and upgrading clinics.
- October 1992: Eskom brings out a policy document entitled "The Integration of RAPS into Eskom's Electrification Programme.
- Late 1992: Reinhold Viljoen (ex DMEA, Development Planning & Energy consultant) retained as IDT electrification programme manager. RAPS consultants EDG (Energy & Development Group) submit proposals to IDT for planning the electrification of clinics and for testing RAPS systems and components.
- March 1993: A preliminary survey of 31 clinics in Transkei starts and stops. IDT clarifies that the programme will proceed region-by-region, in association with the activities of the IDT building team.
- March 1993: Eskom has a "RAPS launch".
- May 1993: EDG appointed as project consultants for initial phase of project to electrify clinics in Kangwane, including liaison with IDT clinic building team, IDT field agents, government service departments and utilities; survey and analysis of energy needs at Kangwane clinics; preliminary design and project budgets.
- August 1993: IDT convenes seminar to present emerging IDT policy on rural electrification.

- **September 1993:** Kescor (Kangwane Electricity Supply Corporation) still engaged in evaluating costs of grid electrification for Kangwane clinics.
- **October 1993:** Seminar to inform RAPS industry about clinic electrification plans.
- **October 1993:** EDG appointed as consultants and project managers for RAPS electrification of ten Kangwane clinics.
- **November 1993:** Revision of above, to five Kangwane clinics and nine in Venda.
- **— January 1994:** Preparation, completion and issue of tender documents (to sixteen PV contractors).
- **February 1994:** Nine tenders received.
- **March 1994:** Tender evaluation in progress.

The time boundary of the present report reflects the "project year" (April 1993 - February 1994) for this reporting project, funded by the Energy for Development Directorate of the Department of Mineral and Energy Affairs.

One stated aim of the project was to derive guidelines, where possible, from the IDT clinics electrification programme experience during 1993 which could have replicable value for future stages of this programme and for other similar endeavours to electrify rural community institutions in the future. However it is evident from the summary above that the first stages are very much still in process — for example, no clinics have yet been electrified, using RAPS, under the programme. The evaluative comments and recommendations which can be made at this point are therefore restricted to commentary on the preparatory stages achieved in the reporting period, together with rather speculative observations for the future.

IDT's emerging policy for supporting electrification of rural community facilities

From the viewpoint of this report, two main IDT electrification-programme activities during 1993 are distinguished: (a) the development and negotiation of rural electrification policy, and (b) concrete implementational steps towards RAPS electrification of clinics. Although linked, these topics are of a different order. The latter is approached in more concrete detail in the report and is more specific, while the former provides essential background to the wider issues.

At a seminar mid-1993, IDT presented a document ***Towards a rural electrification policy for the Independent Development Trust*** reflecting work accomplished so far in refining/defining IDT's role in rural electrification and developing guidelines and mechanisms for implementing this role, in conjunction with other major role-players. The major aim of the seminar was to establish channels for partnership with utilities and the DBSA. Points from the seminar and policy document are selectively summarised below:

IDT mandate and broad approach:

The mandate is to uplift the poorest sections of South African society. This directs attention to areas of greatest need, rather than the "most advantageous" grant-funding opportunities. Principles include empowering such communities for their own upliftment, through infrastructure, mobilisation, "giving a voice", etc. Amongst the basic quality of life and health issues, energy is seen as a prime building block, but given the scale of demand, attention should initially focus on assisting *institutions* with energy needs. Rural institutions are the focus for electrification assistance, because in principle community members

have equal access to institutions, whereas domestic rural electrification seldom serves the poorest community members. Rural *domestic* energy use will continue to revolve pervasively around non-electric fuels. However, domestic energy provision for staff at rural institutions would be a high priority.

Allocations and motivation:

Approximately R55 million could be allocated by IDT for assisting energy provision to such institutions, in the current financial year (to June 1994). IDT would like to gear up their grant funding by leverage, requiring a well designed programme incorporating a range of other major players. Public sector pricing of rural service provision does not reflect externalities and socio-economic or welfare benefits. IDT grant funding could help to address this allocative failure, by assisting with the financing of initial capital costs for welfare-directed infrastructure. It would be directed at covering the "non-economic" portion, supplementing cost-recovery investments financed by loan funders and/or utilities.

Suggested allocation principles:

Factors which need to be considered in rural electrification decisions include patterns of settlement and land use, existing grid distribution, terrain, and complex flux questions (including uncertain developments in the electricity distribution industry, changing conditions of access and security in some areas, demographic shifts of populations, land redistribution, political restructuring, etc.) which need to be catered for as far as possible, but which may lead to a degree of opportunism in allocating scarce resources in the shorter term.

Given scarce resources and competing needs, total coverage would not be possible in the foreseeable future. Criteria are therefore needed for deciding allocations per region, for identifying suitable sub-regions, and prioritising target institutions. Regional allocations, from the total budget, could be apportioned on the basis of population, population density, the numbers of clinics and schools; and indicators of need, such as the numbers of schools and clinics per capita, infant mortality rates, and literacy rates. Broad targets over 5 years could be: 75% of rural institutions electrified (about 5% at present); 40% of rural households (about 5% at present).

Process:

Identifying sub-regions for programme assistance would require gathering demographic, institutional and energy data, and the establishment of grid expansion plans and costs of electrifying target institutions. IDT would assist local-level utilities to do this and provide funding assistance for this purpose. For efficiency, it would be necessary to address consolidated needs at one time, on a programme basis, rather than support isolated electrification initiatives. The proposed unit was a "sub-region", e.g. five or six magisterial districts, containing perhaps 50 - 60 schools and 10 - 15 clinics. This is considered a manageable size, and suitable for gaining additional funding support. Smaller units might be below consideration of loan- or grant-funding partners, larger could become too complex or unmanageable.

In the case of grid electrification schemes, IDT would approve a block grant to the utility against performance targets. Off-grid electrification for institutions where grid connection is too expensive would follow an open tender process (design, supply, installation and maintenance) for RAPS systems; all stages would be open to utilities, and to industry. Financing could take the form of

direct grants to communities or local government service departments, with the objective of funding capital costs and of subsidising operating and maintenance costs to manageable proportions. Maintenance costs would be administered through membership in a Joint Maintenance Fund. Utilities would be asked to participate in the fund and invited to supervise maintenance contracts.

Steps towards implementation

The initial requests which IDT's Health and Rural Development portfolio had received for clinic upgrading had not been very systematic. A broad approach was first considered, with the aim of establishing the "universe" of clinics in the country (and their locations, size, functions, etc) to be followed by a classification procedure allowing rational selection of clinics for electrification. However, IDT decided instead to proceed on a region-by-region approach, coupled to activities of its clinic building team which was already operating in some regions.

Kangwane was selected for the first electrification project. RAPS consultants of the Energy and Development Group (EDG) were appointed for the initial phase, entailing

- liaison with the IDT building team, electrification programme manager (Reinhold Viljoen), IDT field agents; and with health authorities and electricity utilities
- a survey and analysis of energy needs in Kangwane clinics
- evaluation of energy supply options
- definition of technical options, preliminary design and project budgets for implementation

The electrification programme decided to investigate the needs of all clinics in Kangwane, not only the 15 new buildings or upgrades falling under the IDT building programme. Out of 58 full clinics in Kangwane, operated by the Kangwane Department of Health and Welfare, 22 were identified for electrification, by grid or RAPS.

Kescor, the electricity utility, were asked to quote on the costs and timeframes for grid electrification in each case. Initially, this led to identification of 10 clinics requiring RAPS electrification (later revised to five, following changes in Kescor's financial situation). EDG investigated clinic energy needs, as part of a regional electrification task team (including the IDT electrification programme manager, Kescor, and Eskom), assisted by individual district hospital staff. Essential clinic energy needs were identified as: indoor lighting, security lighting, communications, vaccine refrigeration and water heating. Energy needs for nurses' accommodation were identified as: indoor lighting, security lighting, domestic refrigeration, cooking, radio/TV, water heating and space heating.

EDG prepared a preliminary design for PV systems to meet the *electrical* energy needs, based on a design load of between 1.7 and 2.1 kWh/day. Budget costs were submitted to IDT (in the region of R50 000 per installation).

EDG had concurrently initiated vaccine refrigerator tests, to investigate whether locally manufactured fridges could meet World Health Organisation standards.

Eskom's role

In October 1992, Eskom had brought out a policy document on "The Integration of RAPS into Eskom's Electrification Programme", stating *inter alia* that

> "Eskom shall assist the Independent Development Trust in the electrification of rural clinics using RAPS by compiling system specifications, issuing enquiries, adjudicating tenders and negotiating installation, commissioning and maintenance contracts on behalf of IDT."

And in March 1993, Eskom convened a one-day RAPS launch and workshop, devoted to Eskom's future involvement in off-grid electricity supply and, in particular, to becoming involved in RAPS provision in connection with the IDT clinic electrification programme.

However, at a practical level, there appeared to be little productive linkage between Eskom's stated commitments and the IDT clinics electrification programme during 1993. On the RAPS side, this may have been in part because the pilot project in Kangwane fell outside Eskom's area of jurisdiction. A few Eskom RAPS staff participated as observers, but there was no organised collaboration.

Maintenance questions

A crucial concern for RAPS electrification of rural community facilities is sustainable maintenance.

At one stage, it was suggested that Eskom, with its existing wide coverage of technical maintenance staff, would be in the best position to guarantee maintenance of PV systems for rural institutions. Eskom's participation seemed attractive in offering long-term institutionalised lines of responsibility, likely to survive any restructuring, for example of local government departments. However, from Eskom's point of view, a number of factors make it less attractive or less practical to take on responsibility for maintenance of PV systems in clinics around the country. These include: uncertainties about future costs; restricted rights of access in many of the homeland regions where clinic electrification was envisaged; and limited experience of PV maintenance and repair, except amongst a few regional distributors.

IDT proposed the establishment of a "Joint Maintenance Fund" (JMF), essentially to provide a secure flow of funding for maintenance and repair of RAPS systems installed in development projects, but with further functions such as the issuing of standard maintenance contracts, overseeing the quality of maintenance and repair, and power to terminate or renegotiate maintenance contracts. The JMF could also support training needs. Membership of the fund would be open to all organisations owning RAPS systems that will be maintained in terms of JMF maintenance contracts, and to funding participants, and could therefore include community committees, departments of health and education, utilities, development organisations and funding agencies. This would be a national structure with independent management, formed as a trust or non-profit company.

This proposal however has not fully taken form yet. Amongst other complications, there appear to be political doubts about such a centralised fund serving a spectrum of interests. One possibility is that, in the interim, a number of separate trust funds would be instituted to manage and finance future maintenance and recurrent costs,

on a regional project-wise basis. Although this might limit the opportunities for spreading risk and reducing administration, it would allow disaggregated auditing.

In the case of RAPS electrification for Kangwane clinics, the present approach towards maintenance is that EDG (appointed as consultants and project managers) will supervise a one-year contract for maintenance entered into by the contracted supplier/s, after which maintenance responsibility will be handed over to Kescor.

Tender enquiry

EDG prepared detailed tender documentation and project specifications (some 140 pages) for RAPS electrification of Kangwane clinics. The scope of the contract included the supply and installation, commissioning and hand-over of PV systems for vaccine refrigeration, interior lighting in clinics and staff residences and external security lighting, plus maintenance for one year, the provision of sets of spare parts and delivery of documentation for operation and maintenance.

The specifications envisaged a dual PV system for each clinic, joined by a common bus, so that the critical loads could be supplied by a high-reliability generously sized system (200 Wp PV array, 330 Ah battery at 12 V, covering a vaccine refrigerator with consumption not more than 700 Wh/day) and the remaining lighting and nurses' accommodation loads could be met by a more economically sized unit (300 Wp, 330 Ah, to cover approximately 1000 Wh/day). The common bus was designed to allow surplus energy from either unit to be utilised by the other.

Much of the value of these tender documents lies in comprehensive detail to guide wiring and installation procedures, backed by site layout plans showing required electrical distribution schemes and appliances. Typical diagrams of several components were provided as a further guide to tenderers.

With respect to payment conditions, a small retention component was stipulated, partly payable on successful hand-over (marked by a Final Completion Certificate from the consulting engineers) and the remainder at the end of the one-year "Defects Liability Period".

Extensive preparations were required to produce tender specifications for the initial set of clinics in Kangwane. A portion of this work turned out to be unnecessary, in that Kescor revised its grid-electrification plans, reducing the number of clinics for RAPS electrification from ten to five. Taking a longer view, the overheads involved in drawing up the first batch of specifications could be considered an investment which would assist replication elsewhere. This was partly demonstrated by the revision and extension of EDG's design and supervision contract to include further RAPS electrification of clinics in Venda (18 November 1993).

The processes which had been followed in Kangwane were repeated in Venda, including liaison with the Venda National Development Corporation: Electricity Division, Health officials, and site visits to clinics, assisted by IDT field agents active in the area. Nine clinics in Venda were identified as candidates for RAPS electrification. Tender documents for the supply, installation and maintenance of RAPS systems for these clinics were drawn up, following the approach developed for Kangwane clinics.

Both sets of tender documents were issued on 21 January 1994. The open tender enquiry had been advertised in Engineering News. Sixteen contractors took tender

documents. Site visits were conducted to a clinic in Venda and Kangwane, accompanied by representatives of the Departments of Health, Department of Works, electricity utilities, IDT field agents and consultants. Fourteen of the sixteen potential tenderers were able to visit one or both clinics.

The final closing date for tenders was 14 February 1994. Nine tenders were received and are being evaluated by EDG. Scheduled targets for the supply, installation and handover of PV systems for clinics in Venda and Kangwane are currently as follows:

Appointment of PV contractor/s	March 1994
Supply and installation (Phase 1)[1]	30 June 1994
Supply and installation (Phase 2)	31 August 1994
Acceptance testing and handover (Phase 1)	30 June 1994
Acceptance testing and handover (Phase 2)	31 August 1994
EDG supervision of contract for routine maintenance and emergency breakdowns	until July and August 1995

Grants to utilities

Of the R55 million which IDT may allocate, as grant support for electrification of rural institutions, it is intended that a large portion will be allocated by the end of the 1993-94 financial year. If so, this will largely take the form of block grants to utilities. While these allocations may be completed in the near future, it is expected that implementation of associated electrification schemes would extend several years ahead.

In addition to Venda and Kangwane, IDT has established cooperation agreements with other major utilities, namely Eskom, BECOR in Bophuthatswana, TESCOR in Transkei and the Department of Public Works in Ciskei. The expected process is that utilities would draw up a schedule of rural institutions for electrification (in consultation with local authorities) and prepare costs, timeframes and a division amongst grid and RAPS targets. Significant planning and information gathering is required to reach this stage, and IDT is providing supplementary funds to utilities for planning assistance. One obvious requirement for a planned approach in a region is to have information about the universe of clinics, schools, etc in the region to be served.

It has been disappointing that firm workable agreements between IDT and Eskom did not appear to be reached during 1993.

It is not clear that Eskom has developed greater capacity for RAPS implementation, during 1993, as a result of the IDT programme. Rather, there has been a sense of Eskom hanging back, at an ***operational*** level, or of being delayed by not articulating with concrete IDT-sponsored initiatives. This contrasts with one of the hopes of the programme, namely that the participation of utilities (particularly Eskom, with its strong technical and organisational capacity) would help to promote technical expertise and standards in the RAPS supply industry. This may still come about, but to date has happened only to a limited extent, independently of the IDT programme.

On the other hand, at an ***electrification policy*** level, the presence of the IDT programme has (a) helped to keep RAPS electrification firmly, or at least visibly, on Eskom's agenda, and (b) has probably helped to clarify Eskom's consideration of rural

[1] Phase 1 and 2 represent scheduling which follows progress of the IDT building team.

electrification strategies. At this important level there has been considerable convergence between the way IDT has spoken about the electrification of rural community institutions and similar expressions of support and prioritisation from Eskom. Further, the place for external grant funding or external concessionary loan finance to offset the "uneconomic" portion of rural electrification initiatives has had strong presence in rural electrification policy discussions, within Eskom and more widely.

Evaluation

From the outside, progress in the IDT clinics electrification appeared slow during 1993. From the inside, it is evident that participants were under great work and time pressures. There was a conflict between implementation on the one hand, and requirements for planning and preparation on the other. The scale of the programme, the gaps in information, the lack of established implementation mechanisms and the fragmentation of local government service departments and electricity utilities all led to a need for more comprehensive planning, preparation and negotiation.

Early in the programme, IDT had hoped it could act primarily as a grant-funder, and that implementation could be carried out at arms length, for example by Eskom. However, during 1993, the IDT electrification programme found itself increasingly in the position of operational programme management, and even project management, rather than the more confined functions of grant-funding policy, allocations and monitoring.

The report contains evaluative comments on this and other matters, including further commentary on the role of Eskom, and wider rural energy policy formulation and implementation.

Focusing more narrowly on the pilot RAPS electrification projects in Venda and Kangwane, several steps during 1993 may set examples for possible replication elsewhere.

- The **liaison process** (between IDT, the RAPS consultants, local governement service departments and utilities and health care staff) seems to have been fairly open and thorough. This contrasts with a number of past projects, and sets a useful example.

- In Venda particularly, the collaboration between IDT field agents and RAPS consultants was productive. Well-trained and motivated **development workers operating at a local level** can provide a valuable interface between consultants, local staff and communities, and local government departments. This model could usefully be replicated, though it is likely that it would take different form in different localities.

- The **energy needs assessment** process, although quite sharply targeted and perhaps constrained by the projected electrification task, provided an example which was probably more consultative and more detailed than in most other previous RAPS electrification projects.

- The **technical preparation** conducted by EDG should have benefits extending beyond the present pilot projects. Included here are the testing of physical components (in particular, local DC vaccine refrigerators); the international advice which EDG sought in preparing preliminary designs; investigations into

lighting options for rural community facilities; and several other design-related activities.

- Many of the detailed design investigations became incorporated in the **technical specifications for tender.** These specifications should have considerable scope for beneficial replication, providing they are placed by IDT in the public domain. Such specifications should nonetheless be regarded as evolving, and open to modifications, additions and subtractions in the light of experience.

- The **format** and setting-out of **contractual responsibilities in the tender enquiry** provides a useful and replicable model, following the General Conditions of Contract for use in connection with Electrical and Mechanical Engineering Work, as prepared by the South African Association of Consulting Engineers.

- The **form of contract**, with a 1-year defects liability period and a modest hold-over portion of payment, needs to be monitored in practice but establishes a possible model for maintaining a level of contractual responsibility, by the supplier, for performance to specifications while not imposing unduly onerous conditions which might lead to higher prices.

- The **tendering process** (including preliminary discussions with RAPS supplier companies, and site visits to clinics for potential tenderers) has probably helped to establish greater communication, sense of common purpose and professionalism in the local RAPS industry.

- It is too early to say whether models for **training**, at different levels, will be successful and replicable, but it is likely that preparatory work conducted by EDG will be a valuable resource for future projects.

- Project management by consultants is one model amongst several for making the implementation links between IDT grant finance and the installation of RAPS systems at clinics. So far it is the only one which has been tried out. It has entailed a learning curve for IDT, which was not well prepared for **handling professional contracts** of this nature in an efficient and routine manner. If this model for implementation continues, the gains should be replicable.

- Allied to this is the impression that IDT is **severely understaffed** for the massive responsibilities and challenges assumed by the organisation. Although it is likely, over the next few years, that IDT will no longer bear such heavy unaided responsibilities for health, education, agriculture, employment creation, drought relief, etc, it is also likely that IDT will professionalise and staff its various functions in a more sustainable way.

- It remains difficult to say, at this point, whether successful models have been established between IDT and utilities — and within utilities — for sustainable RAPS electrification of rural community facilities.

- It is also difficult to judge at this stage whether the present arrangements for ongoing maintenance and running costs of RAPS systems at clinics in Kangwane and Venda will be robust, and whether wider plans for establishing one or more "Joint Maintenance Funds" will be effective.

IDT's decision to reformulate a national programme of implementation into a **region-by-region approach** was driven by practical obstacles, including the time-consuming nature of negotiations in each region, the lack of national infrastructure for rural electrification, and lack of knowledge about needs, plans and capacity in each region so that it was not feasible to gain a prior picture of overall scope of the clinics electrification programme. It also reflected area-specificity of clinic building team operations (including their attempts to interact more directly with recipient community structures). It is clear that some of the fragmentation, variable access and variations in regional planning and servicing capacities are a consequence of apartheid homeland policies. However, it is likely that these aspects will have a momentum which continues beyond the forthcoming national and regional elections. Moreover, the size of the country is a lasting factor. For these reasons, **it is likely that a regional division of grant-funding support and regional devolution of allocation and implementation responsibilities will continue**, hopefully backed by coherent national policies. IDT's suggested criteria for inter-region allocations, although based on objective criteria of scale of needs, may not survive new consolidated regional power constituencies, unless IDT is allowed to maintain its measure of independence in making such allocations (which is probably unlikely). The strategy of addressing regional needs in **programmatic units large enough for mobilising major finance, but small enough for effective management** (e.g. a cluster of magisterial districts) seems reasonable, but other financial, organisational and political factors may cross-cut this proposal.

Recommendations

A number of specific recommendations have been made in the report, relating to RAPS aspects of clinics electrification. These are not intended to be comprehensive, but are more in the nature of "add-on" suggestions which could help to add value to what has been achieved so far. They include:

Technical aspects

1. The technical performance of clinic RAPS systems (and appliances) should be monitored after installation. It is recommended that at least one clinic installation should be monitored, as simply as possible, but on a continuous basis, to establish energy utilisation and supply, and the utilisation and performance of appliances. A great deal of work has been invested in the design specifications for these systems, and it would be a loss if adequate technical assessment of the design does not take place.

2. In view of the difficulties of on-site monitoring, it is also recommended that an identical system should be installed at the Silverton Renewable Energy Demonstration Centre, operated with controlled loading, and monitored thoroughly. This would also help to serve informational, promotion and training purposes. There are current discussions about upgrading demonstration PV systems at the REDC, and this would be a good way of exposing interested parties to a well-engineered PV system, which has important development and welfare applications.

3. IDT should place the specifications which EDG developed for Kangwane and Venda clinics in the public realm, in support of broader efforts to develop standard specifications for RAPS systems.

Social delivery

4. Participative follow-up enquiries are recommended to find out how clinic staff perceive the benefits and possible deficiencies of installed RAPS systems, in relation to their work and domestic well-being. These enquiries should not be restricted to the use of electricity, but should include other fuel use and also non-energy aspects of their work and domestic context. This will help an appraisal of how far the electrical supply has brought benefits, relative to other concerns.

5. Liaison should be maintained quite regularly with local government service departments and utilities, in an organised way. There must be continuity after initial implementation.

Planning

6. Resources should be devoted to serious cost-benefit evaluation of electrifying rural community facilities.

7. There should be sufficient coordination between agencies responsible for health, education, water supply, employment creation, etc, to allow a coordinated approach to electrification of rural community facilities, in particular where rural grid electrification schemes can serve multiple institutional (and private) consumers.

8. More reliable and comprehensive databases should be developed to map existing rural community facilities and their functions throughout the country.

9. An integrated developmental approach should be promoted, which weighs up the appropriate balance between different service needs in a rural community and which takes account of economic production opportunities. Supply-focused programmes (such as rural electrification) should be proactive in seeking a more integrated developmental approach and should seek to strengthen local-level demand structures.

Utility recommendations

10. Rationalisation of the electricity distribution industry should seek to strengthen regional capacity for rural electrification. Preparations for greater involvement in RAPS and grid supply for rural community facilities should be premised on a drive towards such rationalisation.

11. Transfer of RAPS knowledge to electricity utilities should be promoted through selective appointments of specialist RAPS consultants or contractors to work alongside utility staff on initial RAPS projects.

12. Utilities should provide technical RAPS training to appropriate staff.

13. If utilities are prepared to take a more integrated approach to rural energy service provision, they should appoint or train the equivalent of "field agents" with local knowledge of development issues.

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1. Introduction

Rural poverty is severe in many areas of South Africa, especially in regions of the country which were demarcated as "homelands". Average income levels are very low, and often household incomes are dependent on remittances from migrant workers, or pensions and other transfers, rather than rural production. Social indicators of poverty, such as infant mortality rates and illiteracy rates, confirm the scale and severity of rural poverty.

The Independent Development Trust (IDT) has a central place in this report, which documents an initiative to electrify rural clinics in South Africa. The Independent Development Trust was established in 1990, with an initial grant of R2 billion from the South African government. The aims were to alleviate poverty and contribute to development, targeting in particular the poorest of the poor.

Improved health care has been one of IDT's priorities. Clinics are being upgraded and new clinics built. The question of improved energy supply for existing and new clinics led to initiation of an ambitious clinics electrification programme. This remains a focus of IDT-sponsored electrification, but the scope of IDT's rural electrification policies has expanded to include other community-level facilities, such as schools, water-pumping and public offices.

The reason for restricting IDT's (grant) funding support for electrification to community-level facilities lies in the commitment to serve the poorest of the poor. Electrification for private households, in poor rural areas of developing countries, often provides benefits only to richer households. Community facilities, however, are expected to serve all members of a community.

In the financial year 1993-1994 (which will end June 1994) IDT announced that it was prepared to allocate some R55 million for rural electrification support, enlarging on an earlier allocation of R10 million for clinic electrification. This grant assistance is available both for grid electrification and for off-grid electrification. The latter will be referred to here as "RAPS electrification" and is the focus of this report. RAPS is an acronym for Remote Area Power Supply, covering a range of off-grid technologies for electricity supply, including solar photovoltaic (PV) systems, wind generators, diesel gensets, and others. In South Africa, PV systems are usually the most cost-effective RAPS option for small but regular electricity requirements in locations which are distant from the grid. Diesel gensets are also widely used.

The proportion of the budgeted allocation which is available, respectively, for grid and RAPS electrification is not predetermined, as it should depend on site-specific appraisals of the costs and benefits of each option, in relation to energy needs. However it is clear that a substantial RAPS component is possible within the clinic electrification programme. Among the implications are (1) there is potential for RAPS electrification on a scale which could challenge the capacity of the local RAPS supply industry; (2) reliability, regularity and replicability would have a high priority within such a large-scale project; (3) electricity utilities need to participate, both in their conventional capacity for grid electrification and also in RAPS/grid decisions (and possibly RAPS implementation).

In the past, some hundreds of clinics and schools in South Africa have received RAPS electricity, either within particular projects (such as providing PV power to rural schools in Bophuthatswana, as part of an educational television project) or through ad-hoc initiatives. The record has unfortunately not been impressive, on average,

revealing a number of irregular contracts awarded in haste, with inadequate assessment of users' electricity needs, inappropriate system design, poor installation, inadequate maintenance arrangements and a variety of other problems. These generalisations do not apply to all installations or all past projects. However, disappointments have been sufficiently widespread to engender caution, and at an early stage of the IDT clinics electrification initiative, the Energy for Development Research Centre (EDRC) was consulted for advice on procedures and practices to reduce these risks. As the scale of technical consultancy expanded, this role was taken over by the Energy and Development Group. Subsequently, the RAPS component of the clinics electrification programme has raised the level of professionalism in specifying RAPS systems, awarding contracts, liaising with institutional roleplayers and end-users. This "stepping up" has been arduous and time-consuming. One consequence is that, at the time of writing this report, tenders are being evaluated for the first clinics to receive RAPS systems under the IDT clinic electrification programme; no systems have yet been installed (the target now, for these first systems, is June 1994).

2. Aims of this study

The aims of this study were:

- to monitor, document and evaluate the progress of the IDT clinics electrification programme during 1993, with a focus on the RAPS electrification component;
- to provide a concise overview of programme developments, which may be useful information for agencies and policy-makers concerned with rural electrification;
- to identify success factors and constraints, with particular attention to provision of RAPS electricity for rural institutions;
- to record any guidelines, identified in programme experience during 1993, which may contribute to successful extension of this programme or other similar initiatives in the future.

The time boundary of the study (the year 1993) corresponds to the research funding period and corresponding reporting date. Unfortunately — as anticipated — the clinics electrification programme has proved more complex and has progressed more slowly than initially estimated, and programme targets have been rolled forwards accordingly. As mentioned above, no RAPS systems have yet been installed. It is not possible at this reporting stage to evaluate the full electrification process, and evaluative comments will therefore be restricted to the procedures and processes to date.

The study takes an "observer" viewpoint, and aims at a synoptic overview rather than recording the complex details known to the various programme participants. It was felt that such a synopsis would be useful and more accessible for a wider audience.

3. Sources of information

The means of obtaining information have included:

- liaison with IDT staff and consultants;
- liaison with other participating parties, including Eskom, other electric power utilities, selected departments of health and public works, Development Bank of Southern Africa representatives, the Department of Mineral and Energy Affairs and representatives of the RAPS industry;
- tracking the energy needs assessment process, through liaison with IDT consultants and through additional field visits;
- tracking the specifications and tendering process for RAPS clinic systems.

Particular individuals should be mentioned for their generous contributions of information in support of this study:

Glynn Morris, Christopher Purcell and Mark Borchers of the Energy and Development Group, who have been most involved in the appraisal, design and specification of RAPS systems for clinics, and liaison with the RAPS industry, government service departments and health staff;

Reinhold Viljoen, IDT Electrification Programme Manager, who has played a key role in developing strategy options and coordinating the programme;

Sarah Ward, EDRC, who undertook field appraisals of clinic activities and energy needs in Kangwane;

Mark McCalman (EDRC) who embarked on the first stage of a study of energy requirements and supply options for rural community institutions in Ciskei, unfortunately discontinued due to safety concerns.

4. Initial conceptual discussion

Even a mainly-descriptive study is selective and therefore has a "point of view". With this in mind, it may be useful to identify my perception of the central question posed by the IDT clinics electrification programme (especially its RAPS component). This is:

> *trying to effect changes, at a highly local level, within a larger organisational and institutional framework, when the latter does not pre-exist*

RAPS electrification, in particular, requires careful assessment of specific local needs and activities, in order to design appropriate electricity supply systems. Moreover, the benefits which end-users are able to derive from an improved energy supply can depend quite strongly on the other constraints they experience (e.g. lack of water, lack of security, transport difficulties, intermittent supplies, under-staffing, etc) and the availability of complementary resources. Some conditions will be widely experienced in a district, others may be locally specific. It is also possible that innovations which help to alleviate poverty or contribute to development in poor rural areas may be more dependent on particular individuals, groups or power structures, than in the "modern" economy, where infrastructure and complementary inputs are more comprehensively available. If so, this would point again to the fact that locally-specific conditions, and people, will strongly influence the course of innovations, whether in the form of external interventions or spontaneous developments.

Secondly, however, improved services for poor rural areas usually requires external services support (for instance, in the case of health care, from district hospitals; extension services; regional government departments of health, public works, etc; and financial allocations from local, regional and/or national government). Planning and policy are important ingredients in rationalising the contributions at different organisational levels.

South Africa shows some special elements here, at the present time. For example:

- The pre-1994 South African government has lacked popular legitimacy. The foundation of IDT (initially for three years, over a period of rapid political transition) partly reflects this. By de-coupling IDT from the national government, it was hoped that national funds could be channelled more effectively and more acceptably to poor communities.

- The fragmented "homeland" structure has resulted in a variety of regional administrations, of varying capacity but usually weak, and often also lacking popular legitimacy. Policy and planning within these administrations has been variable in scope, while an unfortunate corollary is that, in general, South Africa has lacked *national* rural development policies or implementing organisations. Token organisations within national government appear to have been prone to corruption or mismanagement (at either end of the national:homeland government relationship), arguably a consequence of lack of legitimacy and openness.

- A trajectory of political turn-over, with imminent elections for democratic government in South Africa, promises rapid dissolution of some aspects/ powers of these structures.

As a generalisation, then, the organisational and institutional environment for promoting improved services in poor rural areas of South Africa is neither adequate nor stable.

While this feature is sharply known in South Africa, it is probably not atypical of other developing countries (such as other Southern African countries), in that the organisational and institutional infrastructure for rural welfare and development are seldom matched to the enormous challenges. A consequence, of direct relevance to large-scale ventures such as the IDT clinic electrification programme (and to somewhat similar programmes, such as the PV-electrification programme in Zimbabwe, funded by the Global Environmental Facility/UNDP), is that new support structures, institutional frameworks, etc have to be developed *as part of the programme*. This makes an ambitious venture more difficult, and slows the pace.

4.1 Schematic models for RAPS electrification of rural institutions

In relation to the points above, the following schematic models are presented (not for detailed discussion but rather to help clarify options within the IDT clinic electrification programme).

- A national programme, with comprehensive inputs from national role-players (public-sector, or public-interest agencies), including financial allocations, prioritisation procedures, technical and organisational support, quality control, maintenance contract supervision, training; substantial grant and/or loan funding.

- National financial allocations, in response to demands presented by local or regional bodies (e.g. local government departments through to particular clinics, schools, community organisations, etc); decentralised project management, maintenance contracts, training, etc.

- Reliance on private sector marketing, possibly backed by national efforts to strengthen the capacity of the local supply industry; allocative decisions taken by local or regional government departments (in the case of government-run rural institutions) from block funds.

- Spontaneous local-level dissemination (e.g. by spreading example), emphasising the role of local actors in decision-making and possibly small local system suppliers; funding assistance (e.g. a proportional grant contribution) from local government or other sources, in combination with local credit schemes; back-up support for local suppliers.

The RAPS component of the IDT clinic electrification programme probably started off closer to the second of these approximate models, and increasingly moved towards the first. By contrast, the Zimbabwe GEF PV-electrification programme started off closer to the third model, and has subsequently moved closer to the first. In each case, the need to establish more comprehensive organisational and institutional support structures became apparent.

The fourth schematic model is more typical of small-scale initiatives serving mainly private buyers of RAPS systems, as described for example in a concurrent DMEA research project report *Institutions and financing for effective dissemination of PV systems for rural development* by Mark Davis (draft report, March 1994).

One of the most crucial aspects of the IDT clinic electrification programme is that is not a RAPS programme, but is viewed as an integrated electrification programme which will sponsor both grid and RAPS electrification, as appropriate. There is accordingly a central role for the electric power utilities (Eskom at a national and regional level, a number of other utilities at regional level). On the one hand, this enforces a planned approach, where, at least, utilities' grid electrification plans have a direct bearing on the RAPS component. This may seem obvious, but in past experiences RAPS electrification has at times been conducted without regard for either future grid extension plans or existing grid supplies in the vicinity. On the other hand, it has foregrounded the possibility that utilities should be responsible for supplying RAPS systems, as part of their normal business.

The latter possibility is most compatible with the second schematic model outlined above, and was an early hope in the clinics electrification programme. This would have implied a role for IDT, principally, as a grant-funder, with joint allocative decisions being made between IDT, utilities and local government departments, while RAPS implementation and project management would be in the hands of the utilities. This hope has not disappeared and may emerge as a *modus operandi*, but in the reporting period of this study, concrete RAPS initiatives within the IDT programme have not yet been project-managed by utilities.

4.2 Programme overheads

In light of the above, attention is drawn to "programme overheads". In putting grant funds to use, a natural concern is the ratio of investments and expenditures in administration, delivery infrastructure, organisation and support services, versus

"getting systems in place on the ground". An associated concern is that of time expenditure. Time spent on preparatory activities can be perceived as delay.

It will be suggested, in the evaluative section of this report, that substantial preparatory activity has been necessary to seek a solid basis for RAPS electrification of rural institutions, and that more will be required. If utilities had been entrusted with the greater part of this RAPS electrification, the need would have remained (but the responsibility would have fallen to a greater extent on the utilities), since neither Eskom nor other regional utilities are geared up for large-scale RAPS programmes.

At this stage of the discussion, a few questions to pose are as follows:

- Has IDT devoted sufficient resources (funding, person-power) to tackle the preparatory overheads and management of the programme?
- Is it possible to build up sustainable structures for the supply and maintenance of RAPS systems for rural community facilities when local government structures are transitory?
- Can utility roles be well established at a time when the electricity distribution industry is similarly in a state of transition?

It is understandable that, despite the shifting sands of accelerating political change, there is an urgent desire to "make a difference on the ground" — and to be seen to have done so. The point must be noted, however, that the overheads in terms of robust management, setting up sustainable structures or simply negotiating with present (fragmented) local and regional authorities are likely to be greater in a time of fundamental structural change.

5. Previous experiences with RAPS electrification of clinics

An alternative to the overheads of trying to set up regular support structures and procedures is a more ad-hoc approach. Two examples from previous South African experience will be briefly described. These illustrate possible adverse consequences of jumping into RAPS electrification contracts without sufficient preparation or regular procedures.

In the mid 1980's, Ciskei clinics were supplied with PV and solar water heating systems, in an irregular deal with an Israeli-based company. Soon afterwards, a survey revealed poor design and installation, no local needs assessment, under-powered refrigerators and scepticism amongst clinic staff who had reverted to gas use. Rural development officials invited an enquiry, to find out if the situation could be rectified, but this was apparently blocked from above.

More recently (from October 1991), just ahead of the IDT initiative, 69 clinics in Lebowa were equipped with PV supply for refrigeration and lighting. Because of the nearness in time, malfunctioning of many of these systems, and public attention towards possible misallocation of funds in Lebowa, this contract has been on the mind of planners and potential recipients in the IDT programme. Some details follow, derived from individuals' investigations.

It appears that the tender was never distributed, but the contract was awarded (January 1992) to a refrigeration company with no previous experience in solar systems. Installation was completed by March/April 1992 — certainly without delay. By 1993 the Department of Health suspected inadequate performance. At this stage the contracting supplier company could not be traced. A concerned manufacturer of components which had been used in these systems undertook a diagnostic survey and

found (from a sample of 28 out of 69 clinics) that in 40% of the clinics visited, the vaccine refrigerator was non-operational or worked intermittently; in 14% the refrigerators worked but deviated from the temperature range required for vaccine maintenance; in 46% the refrigerator performance appeared satisfactory. In 89% the lighting systems worked. Installation was very poor: PV panels were not correctly oriented (even pointing South); wiring was confused, sometimes leading to incorrect polarity and consequent failures; long cable runs of inadequate cable gauge sometimes reduced PV array power; lights had been nailed insecurely to the ceiling and now hung by their wires.

18 months after installation, no maintenance had been performed. Contacts between Lebowa departments responsible respectively for procurement and maintenance appeared to be strained or inadequate.

The installed systems were probably under-sized (one PV panel per refrigerator, one for the lights). Deep-cycle batteries had been specified, but in 18 of the 28 clinics visited, other less suitable batteries had been installed. Thirteen of these 28 clinics had grid electricity nearby.

It seems that the contract was awarded in haste, and perhaps by irregular routes, since there is uncertainty about who signed the order. It also appears likely that the supply company was squeezed by time pressures and financial pressure. The contract entailed a large order (apparently about R540 000, in an overall budget of R606 000 for 69 clinics) for photovoltaic equipment, which the refrigeration company tried to negotiate with a major PV supplier; the latter required guarantees on such a large order, and when these were not obtained, reportedly offered to take the order from Lebowa themselves and to pay the supply company for installation. Whether this is true or not, together with dispute about honouring the terms of payment, it appears that the supply company conducted the installations at clinics under great pressure, trying to evade negative profit margins. One clinic sister apparently remarked "I couldn't believe it — they were in and out in exactly thirty-eight minutes"; average installation time was estimated at a more conceivable 4 hours per clinic; but the size of the task and the limited time available point to great strain on a supply company with minimal staff.

Some of the lessons to be derived from these examples are

- the advantages of an open tendering process
- potential dangers of entrepreneurs approaching local authorities who may lack sufficient technical evaluation capacity
- the importance of local energy needs assessments
- the dangers of inexperienced, unsupervised design and installation
- the need for enforceable contracts to guarantee performance to specifications
- the need for sustainable maintenance structures
- the danger of straining the capacity or financial viability of supply companies
- the waste of resources when RAPS systems are installed in locations where grid electricity could be provided at less cost

Much of the effort so far in the RAPS component of the IDT clinic electrification programme has been directed towards avoiding such problems.

6. IDT clinic electrification programme: process to date

6.1 Starting ingredients

At the beginning of 1993, IDT intended making some R10 million available for providing electricity at selected clinics around the country.

Applications which had been received for IDT assistance, within the clinics upgrading programme, represented some 380 existing health care facilities in all parts of South Africa. Electricity supply had been specifically requested in a proportion of these applications. However, the process by which applications had been made appeared to be uneven, and it was at least necessary to obtain more information about location and numbers of clinics, circumstances, needs and priorities.

EDRC had provided IDT (September 1991) with a preliminary analysis of energy supply options for rural clinics, and in 1992 had drawn up a set of process guidelines, and visited several Departments of Health and Public Works, Eskom and other utilities, in order to convey information and investigate local institutional and technical capacity for electrifying clinics. EDRC had strongly recommended Eskom participation in both grid and RAPS electrification of clinics, including the needs assessment process.

One of the complicating factors, however, was the fragmentation of electricity supply rights in rural "homeland" areas. Eskom had varying rights of access or participation, e.g. 50% joint-venture agreements with Kangwane and Gazankulu, no rights of access in several other homelands (although in Lebowa and Kwandebele this was under negotiation) and limited access in others. The homeland electric utilities, or government departments carrying this function, in turn had variable capacity to extend and maintain their rural networks. For off-grid electricity provision, this fragmentation has had a bearing on the degree to which Eskom, or other utilities, could envisage taking on the roles of RAPS supply, project management or maintenance in different regions of the country.

In October 1992, Eskom brought out a policy document on "The Integration of RAPS into Eskom's Electrification Programme", stating *inter alia* that

> "Eskom shall assist the Independent Development Trust in the electrification of rural clinics using RAPS by compiling system specifications, issuing enquiries, adjudicating tenders and negotiating installation, commissioning and maintenance contracts on behalf of IDT."

This commitment was applauded by observers, but regarded with a measure of caution by Eskom staff who were not sure whether, or how, the statement would be translated into practice.

In the meantime, IDT's Health and Rural Development portfolio, responsible for the clinic upgrading programme, had been stretched by an emergency Relief Development Programme, aimed at trying to ameliorate the impact of the crippling 1991-92 drought. R100 million was allocated (April 1992) for emergency and development aid. Besides absorbing IDT staff and resources, experience gained in this programme came to influence the approach to the clinic building and upgrading programme. The urgency of delivering drought relief, and the accompanying aim of providing aid which would place funds as directly as possible within the control and utilisation of recipient communities, had led to an approach which partly by-passed existing formal

structures and instead emphasised direct funding to communities through their democratically elected committees.

When the IDT "clinic building team" was established in February 1993, following an allocation (September 1992) of R86 million for building and upgrading clinics, it drew on experience from the Relief Development programme (now continued as the Rural Development programme), working through a team of field agents, familiar with local areas, in negotiating community involvement and interfacing between communities and authorities. The clinic building team established a momentum somewhat independent of the electrification aspect of the clinics upgrading programme.

From late 1992, Reinhold Viljoen (Development Planning and Energy Consultant) was retained by IDT to prepare strategy for clinic electrification and, more broadly, develop IDT's rural electrification approach. In addition, the Energy and Development Group (members Mark Borchers, Glynn Morris, Christopher Purcell, previously RAPS research staff at EDRC) submitted two draft proposals for consideration by IDT, in December 1992, one on planning the electrification of clinics, the other on testing RAPS components and systems for clinics.

6.2 EDG clinic electrification planning proposal

This proposal put forward a sequence of steps thought necessary to develop a coherent and workable programme for clinic electrification. The proposal was not adopted by IDT, partly because it envisaged a nationwide approach and considerable preparatory work, while IDT considered that the urgency of getting on-the-ground delivery favoured a region-by-region approach, making use of the existing momentum of the clinic building programme.

Although not enacted, the proposal provided useful pointers which may be summarised as follows. It was proposed to:

- make contact with all interested and affected parties, to facilitate information exchange and establish a common understanding of the scope and limitations of the programme;
- find out the total number of clinics in the country;
- establish the characteristics of clinics, including size and layout, distance from the grid, population served, future plans;
- classify clinics, using this data;
- determine energy needs of existing and new clinics;
- develop a rational approach for selecting clinics, to assist optimal utilisation of resources;
- identify clinics according to the selection criteria.

These steps would then lead into an implementation phase, entailing preparation of specifications (for grid and off-grid supplies respectively) and a tendering sequence, preceded by regional workshops to clarify the process to interested parties.

6.3 Liaison with clinic building team

Initial meetings with the clinic building team revealed that there had been incomplete communication earlier, such that EDG were not fully aware of the progress, approach and preparatory work done by the building team, while the latter did not view energy provision aspects as overly problematic. For example, the building team were not aware of a need for detailed energy needs assessments.

6.4 Clinic surveys

In the period before IDT clarified that the preferred approach would proceed region-by-region in tandem with building team activities (thus by-passing the proposal for a nationwide assessment of clinic numbers, locations, energy needs, supply options, selection criteria, etc) a survey of clinics was initiated, beginning in Transkei. Thirty-one clinics were surveyed in Transkei during March and April 1993. This survey did not proceed further.

6.5 Eskom RAPS launch

On 4 March 1993, Eskom convened a one-day RAPS launch and workshop, devoted to Eskom's future involvement in off-grid electricity supply and, in particular, to becoming involved in RAPS provision in connection with the IDT clinic electrification programme. The principal function was probably to expose regional Eskom distributor staff to these issues. The morning session included a presentation on behalf of IDT, while the afternoon contained workshop sessions covering the following areas: (1) training (customers, installation staff, maintenance staff, sales and customer service staff); system testing and evaluation; standardisation; (2) tendering and procurement; erection and commissioning; maintenance options; (3) funding options and tariffs; distributor targets; marketing and customer service.

Practical Eskom concerns about the implications of incorporating RAPS in their suite of electrification technologies tended to dominate the discussions, while links with the IDT clinic electrification programme tended to take a back seat. The main links back to the IDT programme were: (a) recognition that IDT could be a source of aid funding for projects which would otherwise not be commercially viable, and (b) an expectation that IDT would inform Eskom about the electrification needs (of clinics and schools) in particular rural areas covered by Eskom distributors.

6.6 Development of IDT rural electrification approach

On 27 August 1993, IDT convened a closed seminar (limited in size, to facilitate useful discussion) at which latest thinking and developments in relation to IDT's role in funding rural electrification were presented. Participants included key representatives of Eskom and other electric utilities, the Energy for Development Director of the Department of Mineral and Energy Affairs, DBSA representatives, consultants and EDRC representatives. A document ***Towards a rural electrification policy for the Independent Development Trust*** had been prepared. This document, and the content of the seminar, reflected work accomplished so far in refining/defining IDT's role in rural electrification and developing guidelines and mechanisms for implementing this role, in conjunction with other major role-players. The major aim of the seminar was to establish channels for partnership between IDT, electricity utilities and the DBSA.

Additionally, the seminar included presentations about preparation for PV electrification of Kangwane clinics (see 6.7 below), plus an account of unfortunate previous PV experiences in Lebowa clinics (see section 5).

Some selected points from the seminar and policy document are reported below:

6.6.1 IDT mandate and broad approach

- The mandate remained to uplift the poorest sections of South African society. This directed attention to areas of greatest need, rather than the "most advantageous" grant-funding opportunities. In areas of greatest need, the absorbtive capacity was often low and the resource base weak.

- Principles included empowering such communities for their own upliftment, through supporting infrastructure, mobilisation, "giving a voice", etc. Amongst the basic quality of life and health issues, energy was seen as a prime building block, but given the scale of demand, attention would initially focus on assisting institutions with energy needs; in this way, IDT might be able to play a catalytic role.

- Approximately R55 million could be allocated by IDT for assisting energy provision to such institutions, in the current financial year (to June 1994). IDT would like to gear up their grant funding, for greater benefit, by leverage; this would require a well designed programme incorporating a range of other major players.

- Public sector pricing of rural service provision does not reflect externalities and socio-economic or welfare benefits, but instead is generally based on supply costs. IDT grant funding could help to address this allocative failure, by assisting with the financing of initial capital costs for welfare-directed infrastructure.

- Rural institutions were the focus for electrification assistance, because in principle community members have equal access to institutions, whereas domestic rural electrification seldom serves the poorest community members. Where grid electrification can be taken to institutions, this could however allow expanded domestic access (with possible benefits to the utility through the expanded customer base).

- Rural electrification [in the context discussed] is recognised as fundamentally uneconomic. Grant assistance was more likely to be appropriate than, for example, US-type rural electrification cooperatives. Rural domestic energy use would continue to revolve pervasively around non-electric fuels.

- Given limited resources, it was necessary to establish a logical and coherent basis for making prioritisation/allocation decisions in IDT's rural electrification programme.

6.6.2 Suggested allocation principles

- Factors affecting electricity provision included patterns of settlement and land use, existing grid distribution, terrain, size of a "sub-region" (the proposed unit for programmatic attention).

- There were flux questions, including uncertain developments in the electricity distribution industry, changing conditions of access and security in some areas, and demographic shifts of populations, which needed to be catered for as far as possible, but which might lead to a degree of opportunism in allocating scarce resources in the shorter term.

- There might be capacity limitations (e.g. in the RAPS supply industry) which could indicate decreasing returns of scale at some point.

- Broad targets over 5 years could be: 75% of rural institutions electrified (about 5% at present); 40% of rural households (about 5% at present).

- For efficiency, it was necessary to address consolidated needs at one time, on a programme basis, rather than support isolated electrification initiatives. The

proposed unit was a "sub-region", e.g. five or six magisterial districts, containing perhaps 50 - 60 schools and 10 - 15 clinics. This was considered a manageable size, and suitable for gaining additional funding support. Smaller units might be below consideration of loan- or grant-funding partners, while larger units might become too complex or unmanageable.

- Criteria were needed for deciding allocations per region, and for identifying suitable sub-regions. Regional allocations, from the total budget, could be apportioned on the basis of population, population density, the numbers of clinics and schools; and indicators of need, such as the numbers of schools and clinics per capita, infant mortality rates, and literacy rates. On such criteria (weighted), regions such as Kwazulu, Transkei and Lebowa would stand out as high-need areas. Sub-regions within regions could be identified in consultation between IDT, utilities, departments of health and education, and any other major stake-holders.

- Total coverage was not possible in the foreseeable future. Electrification of rural institutions in Kwazulu alone, for example, would exhaust the budget without full coverage. In the clinic electrification programme, attention would be given primarily to clinics built or upgraded within the IDT programme; but the energy needs of other clinics and institutions in the area would be considered. Day clinics would generally be excluded (for example, this would eliminate 50% of Kwazulu clinics from the programme). In the case of schools, where the benefits of electrification were not well established, limiting criteria would be used initially (e.g. restricting attention to schools which have an adult education component, are used in shifts, or have additional community uses). These might include some 10% of rural schools.

- Energy provision for staff at rural institutions was a high priority.

6.6.3 Process

- Identifying sub-regions for programme assistance would require gathering demographic, institutional and energy data, and the establishment of grid expansion plans and costs of electrifying target institutions. IDT would assist local-level utilities to do this and provide funding assistance for this purpose.

- In the case of grid electrification schemes, IDT would approve a block grant to the utility against performance targets.

- Off-grid electrification for institutions where grid connection is too expensive would follow an open tender process (design, supply, installation and maintenance) for RAPS systems; all stages would be open to utilities, and to industry. Financing could take the form of direct grants to communities, departments of health, or of public works, with the objective of funding capital costs and of subsidising operating and maintenance costs to manageable proportions. Maintenance costs would be administered through membership in a Joint Maintenance Fund (see 6.7.7 for further comment). Utilities would be asked to participate in the fund and invited to supervise maintenance contracts.

- In the case of RAPS electrification of Kangwane clinics, it was anticipated that EDG consultants would put out the tender enquiry. There would be independent adjudication of tenders. The process could be replicated if successful.

- IDT (Health and Rural Development portfolio) hoped to obtain approval for special disbursement procedures to facilitate rapid response and reduce administration overheads. At present, grants and payments below R100 000 could be decided at portfolio level; up to R1 million required approval at 2-weekly meetings; larger amounts required approval by Trustees, which might take a month or more. The strategy would be to gain acceptance of agreement on sub-regional units qualifying for the assistance, followed by block grants per sub-region, to be managed on a draw-down basis.

- Where leveraging of IDT grant funds could be achieved, for example through DBSA concessionary loan finance or international aid, this might entail more complex administration of funds.

6.7 Clinics electrification in Kangwane

The attention given to broader rural electrification policy formulation, exemplified in 6.6 above, may have led to a period of some months when less attention was given to concrete steps in the clinics electrification programme.

In this period, it also appears that potential Eskom participants, such as members of the "RAPS Technical Working Group" (convened by Eskom), became unclear about their role in relation to IDT's plans, and proceeded to discuss technology options, specifications, maintenance requirements, etc, according to Eskom lines of responsibility but with little coordination between Eskom and IDT at the concrete implementation level.

As a first move towards concrete implementation, the decision was made to investigate the electrification of clinics in Kangwane, where the clinic building programme was engaged in building three new clinics and upgrading twelve others (excluding additional day clinics). EDG were appointed (24 May 1993) for the initial phase of the electrification project. This phase entailed

- liaison with the IDT building team, electrification programme manager (Reinhold Viljoen), IDT field agents; and with health authorities and electricity utilities
- a survey and analysis of energy needs in Kangwane clinics
- evaluation of energy supply options
- definition of technical options, preliminary design and project budgets for implementation

The electrification programme decided to investigate the needs of all clinics in Kangwane, not only the 15 new buildings or upgrades falling under the IDT building programme.

6.7.1 Clinics in Kangwane

The Kangwane Department of Health and Welfare (DoHW) currently operates some 58 full clinics and about 40 further subsidiary day clinics or mobile clinics. The DoHW would like to see all the full clinics electrified, but not day clinics. At present 36 of the clinics are already connected to the grid (Kescor is the electricity distribution utility in Kangwane, a 50% joint venture with Eskom), leaving 22 eligible for electrification, either by grid or by RAPS.

One of these 22, one was partially electrified, with a PV system attached to nurses' accommodation, while several had small PV systems for two-way radio communications (installed in 1984-85 and now in poor condition).

6.7.2 Feasibility of grid electrification

Kescor were asked to quote on the costs and timeframes for electrifying those clinics reasonably close to the grid. This process took some time. By September, Kescor had confirmed that 10 of the 22 non-electrified clinics were unlikely to be grid-connected within the next five to ten years, while 8 could be grid-electrified within the next year, at costs ranging from about R2 000 to R70 000 per clinic. The other four sites remained to be evaluated.

Evaluating the costs and the likely cost-benefits of rural grid extension is often complex. For example, in one instance, Kescor quoted R350 000 to reach a clinic via an 8 km 22 kV line extension, but it was noted that the extension could take in two schools along the way. This simple illustration is an example of the more general problem that multiple benefits (and a potential sharing out of costs) must often be considered in a grid extension scheme. Another factor which can affect both present costs and future capacity to expand is the choice of grid extension technology. Kescor presently only considers standard rural grid technology (e.g. 22 kV distribution) and does not employ cheaper alternatives such as single phase lines, single-wire-earth-return or intermediate-voltage distribution (e.g. at 3.3 kV). Through the use of such lower-cost options, where technically appropriate, and by considering the benefits to multiple users rather than only to a single clinic, cost-benefit estimates would perhaps come out differently. However, a longer timescale also needs to be considered. Part of the reason, presumably, why Kescor favours standard rural grid technology is that it provides a firmer basis for meeting expanded demand over time.

Other aspects of note included boundary questions. In one instance, Kescor quoted approximately R160 000 to connect a clinic which was only 3 km from an existing supply point. The problem here was: *that* supply point was on Eskom power. (This situation, not uncommon along the lacework borders of "homeland" areas, obviously requires rationalisation of supply authorities to avoid wasteful expense.)

In practice, it is not only cost which influences the feasibility of grid extensions to rural institutions. The existing capacity of utilities is often a limiting factor; existing electrification plans (reflecting this capacity) may indicate that grid electrification in a particular area is unlikely within a reasonable timespan, even if the cost of reaching this area is not the main obstacle.

Kescor subsequently revised its estimated ability to provide grid connections to clinics. Initially, ten clinics were identified as candidates for RAPS electrification (and unfortunately the preparations proceeded for all ten clinics). At a later stage, this number was reduced to five. It seems that Kescor's revised approach in part reflected a change in ownership of assets, whereby Eskom took over responsibility for bulk supply infrastructure, nominally releasing more resources which Kescor could use for distribution.

6.7.3 Energy needs at Kangwane clinics

EDG investigated energy needs, as part of a regional electrification task team (including the IDT electrification programme manager, Kescor, and Eskom), assisted by individual district hospital staff. Essential clinic energy needs were identified as: indoor lighting, security lighting, communications, vaccine refrigeration and water

heating. Compared with previous assessments elsewhere, a strong desire for outdoor security lighting was noted.

IDT believes that high priority should be placed on facilities to improve the living environment of resident staff in rural clinics and schools. These are often unpopular and demanding postings, making it more difficult to maintain continuity of skilled, motivated staff. Energy needs for nurses' accommodation were identified as: indoor lighting, security lighting, domestic refrigeration, cooking, radio/TV, water heating and space heating.

Not all of these energy needs should necessarily be met by electricity, and it is clear that the thermal needs (e.g. for cooking and water heating) would not be met by a RAPS electricity supply.

Existing energy use in non-electrified clinics typically included:

- a gas refrigerator, used for vaccine storage and sometimes other purposes
- lighting from gas and paraffin lamps, and from candles
- gas cookers for heating water and sterilisation
- a solar radiophone (often operational only during the day, due to damaged batteries)

Gas deliveries appeared regular, but in amounts which were not always sufficient for all needs, while access to paraffin was irregular. The gas fridges appeared to be operating slightly above the temperature range recommended for vaccine storage.

There were cases where nurses used car batteries for powering TVs or used a generator for powering lights and TV.

Water supply is an intense concern in the area. In general, however, the constraint is considered to be a lack of water rather than a lack of energy for water pumping. Clinics are served by road tanker water deliveries. Energy for water pumping was therefore not included in the identification of clinics' energy needs.

In day clinics there may be a demand for radio communication and lighting. However, day clinics were excluded from investigation.

Later in the year (October 1993) an EDRC researcher, Sarah Ward, visited clinics in the Shongwe ward of Kangwane, partly to back up EDG's appraisal of energy needs and partly to gain broader contextual information. Her report from this visit (with photographs) is included as Appendix A in this report. The energy-related findings corresponded very closely with EDG's earlier assessment.

6.7.4 Preliminary design of PV systems for Kangwane clinics

EDG estimated the preliminary design load for the ten Kangwane clinics likely to be served by PV systems as ranging between about 1.7 and 2.1 kWh/day.

Typically this would include about 700 Wh/day for a vaccine refrigerator (no freezing required), 500 Wh/day for indoor clinic lighting, about 300 Wh/day for nurses' accommodation and 400 Wh/day for security lighting. Variations reflected the size and lay-out of clinic rooms and staff accommodation.

Christopher Purcell (EDG), in consultation with a PV regulator expert, designed a system configuration which incorporated separate PV-battery sub-units allocated to separate energy services, but with a common bus allowing surplus electricity to be

shared. In this way, the most critical load, assumed to be the vaccine refrigerator, can be supplied by a conservatively over-sized sub-unit to enhance reliability, while surplus energy from this sub-unit can also be used, when available, by other sub-units.

Budget costs for these systems were prepared and submitted to IDT, together with estimates of recurrent costs, including maintenance, battery replacements and insurance against theft, etc. Initial system costs were estimated to be in the region of R50 000 per clinic.

6.7.5 Vaccine refrigerator tests

The World Health Organisation (WHO) sets out strict specifications for vaccine refrigeration and refrigerators, and tests refrigerators to WHO standards. One PV-powered vaccine refrigerator available in South Africa has been tested to WHO standards, while other locally available models (generally cheaper) have not.

IDT accepted a proposal from EDG to test the performance of local PV-powered refrigerators, motivated on grounds of possible appliance and system cost savings, and benefit to local industry. The tests were conducted in an environmental chamber hired from Eskom, largely following WHO performance criteria.

None of the tested fridges met all WHO criteria. One of the main limitations identified was insufficiently precise temperature control, and it was suggested that more sophisticated thermostats (a minor modification) might resolve this problem. Industry participants were keen to try such modifications. It was also suggested that WHO specifications may in some respects be overly conservative, designed to cover extremely adverse environments.

Measured power consumptions of some of the locally supplied refrigerators were lower than typical WHO-approved models. This could carry cost benefits by reducing the size of PV system required, in addition to the potentially lower appliance costs. However, the ability to freeze icepacks (as used in transporting vaccines from supplier clinics to satellite day clinics) appeared limited. In the case of Kangwane clinics, this facility is not a requirement, but for other situations elsewhere in the country this limitation may need further investigation.

6.7.6 Evaluation of alternative energy supply options

Non-electrified Kangwane clinics, like most non-electrified clinics in South Africa, are supplied with LPG (liquid petroleum gas) for refrigeration and other energy needs. Even if a clinic were provided with PV electricity, LPG supply would most likely continue, since PV supply is too expensive for thermal applications (cooking, water heating, sterilisation, space heating). PV-powered refrigeration is generally more expensive than LPG- or paraffin-powered refrigeration, although it may have advantages in terms of reliability and convenience; and even if vaccine refrigerators are PV-powered, it is likely that staff domestic refrigerators would be powered by LPG or possibly paraffin.

In view of the existing distribution of LPG, the probable need for this to continue, the potential benefits of improved reliability and rationalisation of fuel distribution to rural institutions, and the relatively high costs of PV electricity, it was necessary to consider whether greater reliance on LPG (e.g. for vaccine refrigeration and routine lighting needs) and reduced reliance on PV supply (e.g. only for communications equipment, emergency lighting needs) would provide a more advantageous energy

mix. At IDT's suggestion, Bill Cowan (EDRC) prepared an independent evaluation with the aim of highlighting counter-arguments in favour of LPG rather than PV (see Appendix B), as a contribution to balanced debate. Part of the counter-argument emphasised the general importance, for rural development, of transport. EDG addressed the same question. Both concluded that LPG could be cheaper. The EDG appraisal concluded that advantages of PV supply probably outweigh the cost differential, and therefore recommended PV-powered lighting and vaccine refrigeration where grid supply is not feasible.

6.7.7 Maintenance for PV systems

Although well designed PV systems have relatively low maintenance requirements, nonetheless sustained reliability over many years depends on appropriate routine and emergency maintenance arrangements. International experience from the WHO-sponsored Expanded Immunisation Programme has emphasised that satisfactory maintenance is vitally important for the success of PV-powered clinic installations in developing countries.

EDG proposed three maintenance levels: first line maintenance, to be carried out by users (requiring a certain amount of training in basic operation of the systems); second line, entailing regular inspections, for example by visiting district hospital technicians; third line maintenance, entailing six-monthly inspection visits by a solar PV contractor, with diagnostic checks, coupled with call outs in the event of breakdowns.

At one stage, it was suggested that Eskom, with its existing wide coverage of technical maintenance staff, would be in the best position to guarantee maintenance of PV systems for rural institutions. In 1992, the Eskom policy and guidelines document on integrating RAPS into Eskom's electrification programme contained a proposal that Eskom could negotiate maintenance contracts on behalf of IDT. There were proposals that Eskom could audit such contracts and provide last resort back-up. Eskom's participation here seemed very attractive, in offering long-term institutionalised lines of responsibility, likely to survive any restructuring, for example of local government departments. However, from Eskom's point of view, a number of factors make it less attractive or less practical to take on responsibility for maintenance of PV systems in clinics around the country. These include: uncertainties about future costs; restricted rights of access in many of the homeland regions where clinic electrification is envisaged; and limited experience of PV maintenance and repair, except amongst a few regional distributors.

It is possible that in situations where Eskom is responsible for the design and supply of RAPS systems for rural institutions, they will accept maintenance responsibility as well, at least as guarantor. But it is not expectable that Eskom would extend this responsibility more widely.

The IDT approach to this crucial question has been twofold:

a) Instead of pursuing a comprehensive national approach, the clinic electrification programme is proceeding region-by-region, and in line with this, attention is given to the capacity of local regional structures (e.g. the Kangwane DoHW, Department of Public Works, Kescor) to undertake second and third line maintenance functions. In the case of Kangwane, where local capacity appears relatively strong, it has been recommended that the DoHW be responsible for second line maintenance, and that Kescor is most suitable for third line maintenance, which could be based on a 5-year contract between Kescor and

the DoHW. Alongside these recommendations, an enquiry was issued to Eskom, Kescor, Telkom and the PV industry to gain opinions about the costs and structuring of third line maintenance.

b) More broadly, IDT has suggested the establishment of a "Joint Maintenance Fund" (JMF), essentially to provide a secure flow of funding for maintenance and repair of RAPS systems installed in development projects, but with further functions such as the issuing of standard maintenance contracts, overseeing the quality of maintenance and repair, and power to terminate or renegotiate maintenance contracts. The JMF could also support training needs. Membership of the fund would be open to all organisations owning RAPS systems that will be maintained in terms of JMF maintenance contracts, and to funding participants, and could therefore include community committees, departments of health and education, utilities, development organisations and funding agencies. This would be a national structure with independent management, formed as a trust or non-profit company.

This second proposal has not fully taken form (at the time of writing). Amongst other complications, there appear to be political doubts about such a centralised fund serving a spectrum of interests. One possibility is that, in the interim, a number of separate trust funds would be instituted to manage and finance future maintenance and recurrent costs, on a regional project-wise basis. Although this might limit the opportunities for spreading risk and reducing administration, it would allow disaggregated auditing.

In the case of RAPS electrification for Kangwane clinics, the present approach towards maintenance is that EDG (appointed as consultants and project managers) will supervise a one-year contract for maintenance entered into by the contracted supplier/s, after which maintenance responsibility will be handed over to Kescor.

6.7.8 Communicating with the RAPS industry

An IDT seminar was convened on 1 October in Midrand to communicate IDT's broad approach to rural electrification, and more specifically off-grid electrification, to members of the RAPS supply industry. Nearly 50 people attended, including a few Eskom representatives. The scope and the intended process were discussed, focusing on the tender process, forms of contract and maintenance considerations for clinics in Kangwane.

6.7.9 Specifications and tender documents

On 6 October, EDG were appointed as consultants and project managers for the RAPS electrification of (ten) clinics in Kangwane. Further site visits were conducted to confirm preliminary design information. Site plans and building layout drawings were completed for each site. Preliminary design was refined and standardised and tender documentation prepared, including

- formal contractual aspects and definitions — drawing on the General Conditions of Contract (1985) for use in connection with Electrical and Mechanical Engineering Work, as prepared by the South African Association of Consulting Engineers, and associated formats
- a standard technical specification, relating to requirements for the type of PV installations to be installed
- a project specification, providing detailed requirements for the installations, additional to or modifying the standard specification

- detailed schedules of information to be completed by tenderers, and a tender price build-up schedule

It would be informative to include the tender documentation as an appendix to this report, but aside from copyright considerations this would be bulky, since the tender documents for PV systems at five[1] Kangwane clinics alone amounted to about 140 pages.

The scope of the contract specified in the tender documents included the supply and installation, commissioning and hand-over of PV systems for vaccine refrigeration, interior lighting in clinics and staff residences and external security lighting, plus maintenance for one year, the provision of sets of spare parts and delivery of documentation for operation and maintenance.

With respect to payment conditions, a small retention component was stipulated, partly payable on successful hand-over (marked by a Final Completion Certificate from the consulting engineers) and the remainder at the end of the one-year "Defects Liability Period".

The technical specification (encompassing the standard technical specification and project specification) was fairly prescriptive, stipulating *inter alia*

- the size of PV array and battery banks to be installed (the same at each clinic)
- the numbers, placement and types of lights
- the make of battery to be used
- roof-mounting of PV arrays

and a recommended system configuration, entailing separate sub-arrays charging separate batteries but connected through a common bus, for critical and non-critical load circuits, as outlined in 6.7.4 above.

Much of the value of these detailed tender documents lies in comprehensive detail to guide wiring and installation procedures, backed by site layout plans showing required electrical distribution schemes and appliances. Typical diagrams of several components were provided as a further guide to tenderers.

The overall system design, as expressed in the technical specification for Kangwane clinics, allowed limited discretion to tenderers, unless in the form of alternative offers *in addition* to offers meeting the specified requirements, and included the following features:

- A standard design load for each of five Kangwane clinics, comprising 600 Wh/day for vaccine refrigeration, and 1000 Wh/day for clinic lighting and electricity for nurses' accommodation. [This totals less than the preliminary estimates of 1.7 to 2.1 kWh/day noted in 6.7.4 and was standardised for all the clinics, despite some differences in size and staffing.]

- Two identical battery banks to serve (a) critical refrigerator (and possibly radio-telephone) loads, and (b) other loads, each rated at 330 Ah (12 V) — giving approximately 5 days storage for the refrigerator load and 3 for the remaining load.

[1] The scope of the Kangwane RAPS projects was revised: see section 6.7.10.

- A PV array subdivided into 200 Wp for the refrigerator load and 300 Wp for remaining loads, using crystalline PV modules having at least 36 cells per module, a ten-year performance warranty and international standards accreditation.

- A specified number and distribution of 20 W DC fluorescent luminaires for interior lighting, per room and per site. [Rough calculations, from layout diagrams, indicate that the general illuminance levels in the specified designs would be low — in the region of 30 to 60 lux — but possibly sufficient for background lighting. A medical examination light was also specified.]

- In the case of vaccine refrigerators, a focus of attention in off-grid clinic installations, specifications were expressed (a) in terms of performance criteria, including

  - maximum power consumption per 50 l capacity: 700 Wh per 24 hours at 43°C ambient temperature
  - temperature control in the vaccine compartment: 0°-8°C

  plus (b) proved compliance with WHO performance specifications E3/RF4 or similar local tests. However, locally tested fridges would be considered if recommended modifications had been implemented and inspected.

The schedules of information and price build-up schedules, to be completed by tenderers, were extensive (some 54 pages, for 5 clinics) and apparently designed to obtain sufficient information to judge the integrity of discretionary aspects of tenderers' system design, choice of components, completeness of product information, battery regulation decisions and estimates of battery life (vaguely stipulated in the project specification as "rated for a minimum five years effective service", but non-enforceable) and broken-down costings per site.

6.7.10 Revision of Kangwane contract and extension to Venda

Extensive preparations were required to produce tender specifications for the initial set of clinics in Kangwane. A portion of this work turned out to be unnecessary, in that Kescor revised its grid-electrification plans, reducing the number of clinics for RAPS electrification from ten to five. Taking a longer view, the overheads involved in drawing up the first batch of specifications could be considered an investment which would assist replication elsewhere. This was partly demonstrated by the revision and extension of EDG's design and supervision contract to include further RAPS electrification of clinics in Venda (18 November 1993).

The processes which had been followed in Kangwane were repeated in Venda, including liaison with the Venda National Development Corporation: Electricity Division, Health officials, and site visits to clinics, assisted by IDT field agents active in the area. Nine clinics in Venda were identified as candidates for RAPS electrification. Tender documents for the supply, installation and maintenance of RAPS systems for these clinics were drawn up, following the approach developed for Kangwane clinics.

Both sets of tender documents were issued on 21 January 1994. The open tender enquiry had been advertised in Engineering News. Sixteen contractors took tender documents.

6.7.11 Site visits with contractors

Site visits were conducted to a clinic in Venda and Kangwane, accompanied by representatives of the Departments of Health, Department of Works, electricity utilities, IDT field agents and consultants. Fourteen of the sixteen potential tenderers were able to visit one or both clinics.

Apart from the benefit of seeing on-site circumstances and requirements, and communicating with officials and staff, it is reported that this excercise provided an unusually fruitful opportunity for communication amongst RAPS suppliers.

6.7.12 Present stage of progress

The initial closing date for tenders, 7 February 1994, was extended to 14 February 1994. Nine tenders were received, and are being evaluated by EDG. EDG's recommendations will be forwarded to an adjudicating committee, including representatives from IDT, Eskom, DBSA, the Solar Energy Society of Southern Africa and EDRC. Scheduled targets for the supply, installation and handover of PV systems for clinics in Venda and Kangwane are currently as follows:

Appointment of PV contractor/s	March 1994
Supply and installation (Phase 1)[2]	30 June 1994
Supply and installation (Phase 2)	31 August 1994
Acceptance testing and handover (Phase 1)	30 June 1994
Acceptance testing and handover (Phase 2)	31 August 1994
EDG supervision of contract for routine maintenance and emergency breakdowns	until July and August 1995

(followed by handover of maintenance responsibility to Kescor in Kangwane and the Venda National Development Corporation: Electricity Division in Venda)

7. Training initiatives

IDT has supported a project to produce training materials and provide training courses, to assist in the operation and maintenance of PV systems for rural institutions.

It is envisaged that user training would be the responsibility of contractors supplying and installing systems. To assist this, EDG have produced a 20-page guide on operation and basic maintenance, intended primarily for resident health care staff at clinics. One problem which is anticipated lies in the rate of turnover of staff at remote clinics. It may be desirable for district hospitals to offer refresher courses or instruction to new staff.

A second level of training is aimed at installation and maintenance contractors, sub-contractors, and utility or service department technicians. A condensed manual of about 60-80 pages will be prepared, drawing partly from material in the EDRC/-DMEA RAPS Design Manual (the latter is a more specialised and comprehensive reference source, aimed primarily at design engineers). The information is expected to be presented within a 5-day course offered in each region.

[2] Phase 1 and 2 represent scheduling which follows progress of the IDT building team.

8. Wider developments

Much of the discussion so far has concentrated on activities towards electrifying clinics in Kangwane and Venda. This is where the greatest amount of groundwork and detailed technical preparation has occurred, and these particular projects, although relatively small in scope, are likely to serve as important pilot demonstrations of the advantages (and possible disadvantages) of a more thorough, open and professional approach to RAPS electrification of rural institutions than previously seen in South Africa.

Overall, the RAPS side of IDT's rural electrification support is a minor component compared with the grid-electrification component — but has absorbed a disproportionate amount of attention in its preparation, reflecting the less-ready state of utilities, government service departments, industry and consultants to respond to systematic RAPS electrification opportunities.

Rural grid electrification falls outside the focus of this report, but it is recognised that it is artificial to separate grid and RAPS electrification, especially since it appears that electricity utilities will be the primary recipents of IDT grant-funding for rural electrification (both RAPS and grid). This is discussed further below. From a wider rural energy perspective, it is also artificial to separate electricity provision from other fuels, both biomass and the so-called transitional fuels (paraffin, coal, LPG) which underpin rural domestic energy use in South Africa. This will also be discussed, briefly, below.

8.1 Grants to utilities

Of the R55 million which IDT may allocate, as grant support for electrification of rural institutions, it is intended that a large portion will be allocated by the end of the 1993-94 financial year. If so, this will largely take the form of block grants to utilities. While these allocations may be completed in the near future, it is expected that implementation of associated electrification schemes would extend several years ahead.

In addition to Venda and Kangwane, IDT has established cooperation agreements with other major utilities, namely Eskom, BECOR in Bophuthatswana, TESCOR in Transkei and the Department of Public Works in Ciskei. The expected process is that utilities would draw up a schedule of rural institutions for electrification (in consultation with local authorities) and prepare costs, timeframes and a division amongst grid and RAPS targets. Significant planning and information gathering is required to reach this stage, and IDT is providing supplementary funds to utilities for planning assistance. One obvious requirement for a planned approach in a region is to have information about the universe of clinics, schools, etc in the region to be served.

The aim of IDT grant-funding assistance will be to cover the "uneconomic" portion of an electricity supply or electrification scheme (where this is justified in terms of social benefits). In this way, grant funding is intended to extend the scope of rural electrification beyond the utilities' ability for cost recovery and to complement additional loan finance which may be available (also requiring recovery), for example from the DBSA.

Clearly, this may require complex evaluations of cost-recovery potential and the "uneconomic portion" in particular circumstances, and detailed planning would be a necessity. To give an illustration from Venda, a proposed grid extension to serve

clinics could terminate at a commercial tourist resort, requiring negotiations about respective contributions from IDT (as development/welfare aid for the poor) and the utility (as an economic investment).

A further issue which is likely to require greater clarity and resolution is the degree to which utilities (in particular Eskom) will incorporate a policy of internal cross-subsidisation within the utility, using revenues from the existing customer base to offset costs of new electrification in general, and new rural electrification as a subset of this. This may influence the approach to both capital cost recovery and electricity tariffs. At present, this issue is being debated primarily within the context of accelerated urban electrification programmes, but will extend to rural electrification policy as well (perhaps at a lower priority). If there is a policy of internal cross-subsidisation for new rural connections, supplemented by grant or concessionary loan finance from sources external to the utility, a difficult question is whether RAPS electrification will be treated in a similar fashion. There are arguments in favour of compatibility between grid and RAPS cross-subsidisation, but there are also differences (such as the limited capacity of RAPS systems for expanded electricity consumption and hence increasing revenue over time). These matters have not been resolved.

It would appear, thus far, that a productive relationship between IDT and Eskom has not been fully demonstrated. This may partly reflect the complexity (and hegemonic tendencies) of Eskom's organisation. Simple solutions (while preferred *within* Eskom's highly developed policies and operational structure) are less easy to negotiate with external partners. There has been fairly steady negotiation between IDT and Eskom, but a perception of frustration on either side. Some Eskom staff have been concerned about the slow pace of developments, while some non-Eskom observers have suggested that a "go it alone" attitude on Eskom's part has contributed to the frustration. In practice, Eskom seemed poised to proceed with an independent initiative to electrify rural institutions in Natal/Kwazulu during 1993, making use of discretionary Eskom funds, but following further negotiation it is likely that this will now proceed within an Eskom-IDT framework.

The Eskom RAPS Tariff (which has been under development for some years, but hardly ever applied) is now being adjusted, making it more possible for Eskom to undertake RAPS electrification as part of its normal business. Previously, this tariff was widely regarded as unaffordable, or at least a high-cost option, for purchasers of RAPS electricity, since it embodied a high internal rate of return and conservative risk cover for the costs of maintenance and refurbishment of systems. In response to representations within Eskom, and discussions between IDT and Eskom, the discount rate has now been lowered to 15.5% for developmental RAPS applications, such as clinics and schools, and a variety of flexible options allow for grant fund contributions, as follows:

- **Grant funding (e.g. from IDT) to cover both capital costs and maintenance, in full.** Here the expected future costs of maintenance and component replacements, based on the expected lifetime operating costs of the system, would be covered by an up-front grant into a maintenance fund.

- **Grant funding to cover capital costs and a portion of maintenance costs.** As above, but with a partial monthly payment by the customer (e.g. the relevant department of works, health, education, etc) to cover maintenance costs such as labour, transport, insurance, etc, which were not covered by the up-front lump sum contribution.

- **Grant funding to cover capital costs only.** Here the customer would pay for all maintenance costs, including battery replacements, on a monthly basis.

- **Grant funding to cover only a portion of capital costs.** As above, but the customer would also pay cash or a monthly contribution towards capital to Eskom, based on the RAPS tariff, using a recommended discount rate of 15.5%.[3]

These arrangements, if confirmed, will no doubt assist the interface between IDT's grant-funding support and Eskom's business, conducted by regional distributors. The proposed administration of maintenance funds may entail a version of the "Joint Maintenance Fund" suggested earlier in 1993 by IDT, possibly administered by Eskom's Treasury department. The administration could resemble that proposed for a National Electrification Fund, discussed in the National Electrification Forum, and might in time become part of such a fund.

8.2 Electrifying rural schools

Eskom has probably paid as much attention to the question of electrifying rural schools as to rural clinic electrification, and has attempted to compile a database for the numbers of schools in the country (about 19 000 without electricity?) admitting however that figures gathered from different sources often show poor correspondence. IDT on the other hand has focused primarily on clinics thus far, partly because the rural electrification support programme had its origins in the Health and Rural Development portfolio, and partly because there is less clarity about the benefits (in return for costs) from providing electricity at schools. One guideline which has been mentioned is that school electricification would only be prioritised if school buildings are used for other multiple purposes, such as adult education in the evenings.

Electricity and energy needs at rural schools are not well understood. In Eskom's RAPS demonstration projects at schools, the prior assessment of electricity demands was generally not very thorough, and the small amount of monitoring data on subsequent electricity use has suggested that actual consumption levels tend to have been considerably less than expected. The same applies to the large project for providing electricity for educational television in more than 350 schools in Bophuthatswana in the 1980s, although here RAPS electricity was restricted to power for the audiovisual equipment.

Lobbies in favour of using electronic media and forms of distance teaching in rural schools to try to overcome problems of isolation, over-stretched and under-trained staff, and shortages of books, laboratory equipment, etc, seem to have been less prominent in the last few years, perhaps reflecting increased awareness of the organisational and training challenges in upgrading an education system, and shifts of power away from educational technologists towards more organisationally-minded educational activists.

With regard to physical infrastructure, it is believed that buildings, water and sanitation typically come higher on the list of priorities than electrification. Non-integrated electrification approaches, however, would probably overlook local

[3] This information has been extracted from a letter by David Ligoff, Eskom Small Customer Pricing Manager, to Ray Dabengwa, Senior General Manager, Electrification and Industry Restructuring, which was placed before the Eskom RAPS Technical Working Group on 16 February 1994.

prioritisations, especially if electrification (free, or highly subsidised) is offered to school communities, independently of other services or lack of services.

It is understood that the IDT Education portfolio places a lower prioritisation on school electrification, and secondly that it would not favour a national programmatic approach to this question. Earlier difficulties in establishing an effective national trust for disbursing IDT's assistance for schools' infrastructure led to a regionalised approach, and the IDT school building programme presently operates through a number of Regional Trusts around the country. These Regional Trusts have considerable control in allocating grants which they receive from IDT, and it is understood that the IDT Education portfolio would only support schools' electrification (backed by IDT funding) where Regional Trusts have identified electricity as a high priority requirement.

This does raise a problem for coordination of electrification for rural community institutions, particularly with respect to grid electrification. Where a number of such institutions could be served by the same grid extension scheme (clinics, schools, other facilities in a locality) it is difficult to assess the costs and benefits without considering all main institutional users in a locality simultaneously.

8.3 Wider rural electrification and rural energy policy

Within the scope of this report it would be irresponsible to refer to these complex and highly contested issues in more than a cursory way. The discussion is therefore limited to a few summary points.

i) Rural energy needs, and solutions, appear to be less amenable to central policy formulation and effective strategies than urban.

- One constraint is the inadequacy of data. For example, basic demographic data for many rural areas of South Africa is incomplete or unreliable. Even accurate figures for the number of rural schools and clinics in the country have not yet been assembled.
- Local government structures, which might be responsible for gathering information, planning and service provision in rural districts, are fragmented, non-existent and/or likely to change.
- Land distribution and redistribution will impact on rural economies, demography and energy needs.
- Rural areas and rural populations are spread out, and less accessible to coordinated energy-improvement strategies.
- The inter-relatedness of dimensions of poverty in rural areas makes single strategies (e.g. improved energy provision) less likely to have beneficial impact, and requires more integrated approaches to service provision and development.

ii) Rural energy policy (and rural electrification policy) have been sidelined, to some extent, by urban electrification priorities.

- In the vigorous energy policy debates, at the current time, most of the actors are urban.
- The prospect of making rapid and visible gains through an accelerated urban electrification programme has been at the forefront of political attention.
- Much stronger institutional structures (for urban electrification) make this prospect more attainable than improved energy services for rural areas.

iii) It is widely recognised that rural electrification, in the medium term, will only make a partial contribution to the energy needs of rural populations in spread-out underdeveloped areas.

- This turns attention to policies and strategies for improved access to traditional biomass fuels and transitional hydrocarbon fuels, for example the South African "National Biomass Initiative", and enquiries into improved distribution and lower mark-ups for paraffin and LPG.
- These strategies in turn are difficult to implement.
- The subsidiary or at least relatively specialised place for electricity in the rural energy mix has tended to inhibit the systematic formulation of rural electrification policies. It also means that electricity utilities are only part players in the field of rural energy service provision.

It is possible that developments arising from the National Biomass Initiative will lead to some convergence and integration in rural energy service provision, for example if there is coordination of grant funding for tree-growing (etc) projects and rural electrification assistance, preferably backed by a coherent national energy policy. It remains to be seen, however, whether any coordination at a national level can translate effectively into integrated initiatives at local level throughout the country.

There are several respects in which rural electrification should ideally be "integrated" within a wider approach:

- electricity provision should be considered alongside alongside other energy carriers
- allocation of resources, including those for rural electrification, requires planning and decision-making across sectors
- the usefulness of electricity, in rural areas, depends quite strongly on integration with multi-faceted aspects of development and welfare

It is particularly clear, in respect to the provision of electricity to rural community institutions, that it is not the electricity as such which is important, but the contribution which electrification can make to the improvement of other services, such as health and education. This emphasises the importance of an **integrated approach to services provision**, rather than a supply-driven approach to electrification. Secondly, electricity is seldom the foremost *physical* reqirement for improved services and welfare. Water, buildings, sanitation and transport can all be higher priority needs, depending on circumstances. At all levels — in national policy, grant assistance programmes or projects, local government and in local community decision-making — it seems necessary to judge how best to **allocate limited resources amongst competing needs**. Thirdly, the economic base, which exists or is developing in a rural area, is fundamentally important to the sustainability of welfare improvements. The poorest communities are most in need of improved services but perhaps least able to carry forward the benefits, so improved services provision cannot disregard the **fundamentals of local economic productivity and employment.** These summary points represent enormous practical and policy challenges.

With reference to 8.1 above, it seems improbable that conventional electricity utilities, such as Eskom, can be expected to approach rural electrification, by grid or RAPS, in such an integrated way.

8.4 Changes in political control

With South Africa's first democratic elections a few weeks ahead, both current and anticipated changes in political control affect the direction and implementation of programmes such as the IDT clinic electrification initiative. One aspect, which perhaps relates more strongly to the DBSA than to IDT, is that disbursements or loans to homeland administrations are high on the political negotiating agenda and presently subject to vetting or control by the Transitional Executive Council (TEC). At this point, legal opinions have been sought about whether IDT grant assistance requires TEC approval; different opinions have been expressed.

It remains to be seen how a new government will regard IDT's role, with respect to questions such as (a) relative independence in allocating public money, (b) complementarity between DBSA loan funding and IDT grant funding, (c) conformity with ANC reconstruction and development goals. The degree of potential regionalism in the new constitution, which presently appears to change from day to day, may also have far-reaching implications.

9. Evaluative comments

The experience gained in the IDT clinics electrification programme during 1993 could be evaluated from many different angles. From any angle, the evaluation calls for humility. One should recognise the enormous challenges within the programme, and that ideals are hard to achieve (in a short time) in circumstances of rural poverty, with limited resources and within fragmented, transitory institutional frameworks.

In addition, the comments which follow are based on an individual viewpoint and limited knowledge.

9.1 Initial hopes and concerns

It may be worth setting out some of the hopes which were expressed (by various parties) in the early stages of the IDT clinics electrification programme, prior to 1993, focusing once again on RAPS-related aspects.

1) Broadly, it was hoped that a coordinated national programme to electrify rural clinics would bring definite welfare benefits, where urgently needed.
2) Substantial grant funding for electrifying clinics would encourage and catalyse a more rational, regular, systematic approach to choosing between grid and off-grid rural electrification options.
3) Electricity utilities would be drawn in, for assistance with grid electrification but hopefully also as participants in the RAPS electrification processes.
4) The scale of the programme, and the participation of utilities (particularly Eskom, with its strong technical and organisational capacity), would help to promote technical expertise and standards in the RAPS supply industry.
5) This might constitute a kind of breakthrough for developmental applications of RAPS in South Africa, providing a step-up from uneven and sporadic RAPS projects to professional larger-scale undertakings.
6) Experience gained in the clinics electrification programme could provide a model which could be extended to other similar programmes.

Some of the concerns and frustrations which had been expressed, from an early stage, included the following:

1) A concern that the initial batches of applications from regional health authorities for clinic upgrading assistance, and for clinic electrification, had not been systematic.
2) A frustration from IDT's side that they were in a position to make grant-assistance allocations for clinic electrification, but the structures for implementation were not in place. The utilities had not come forward to assume responsibility, while private industry representations were diverse and often out of keeping with the aims of the programme.
3) Frustration in the commercial RAPS industry that potential money was available but information and action plans were not.
4) A broader concern that the transitory, unstable and irregular aspects of local government and service provision within "homelands", and a fragmented electricity distribution industry, would undermine efforts to establish a sustainable programme.

9.2 Implementation *versus* planning and preparation

Sharpened by the experience of trying to mobilise emergency aid to counter the effects of drought, IDT's Health and Rural Development portfolio certainly had a strong sense of urgent needs, and a desire to make a difference, quickly, on the ground. On the other hand, closer appraisal of the scale of the venture, the gaps in information and the lack of established implementation mechanisms all led to a requirement for more comprehensive planning and for devoting time and resources to organisational, institutional and technical preparation.

One way of expressing this dilemma is that IDT (established with a lean staff) found itself increasingly engaged in the position of operational programme management, and even project management, rather than the more confined functions of grant-funding policy, allocations, monitoring and auditing.

The initial R10 million allocation for clinics electrification was relatively ad-hoc, based on an appraisal of existing (1992) requests for assistance. With closer attention, the scope expanded, entailing the formulation of a wider rural electrification support policy, and a larger R55 million allocation for 1993-94. The expansion of scope reflected the scale of near-term *perceived needs*, rather than *existing capacity for implementation*. In practice, the programme was constrained by

- the requirement for many-sided negotiations, due to fragmentation of health and other service authorities and electric utilities
- a lack of preparedness, both in terms of information and planning (e.g. how many clinics in a region, or in the country? where? serving how many people? what plans for rural grid electrification? and so on), and weak existing capacity in many of the regional service authorities
- complex questions of legitimacy, including who would own assets, and what legitimate, long-term structures could take responsibility for future operation and maintenance

Within the electrification programme, the first approach proposed (as exemplified by the EDG planning proposal referred to in 6.2) entailed a systematic collection of information about rural clinics and associated electricity needs in all parts of South Africa, followed by the development of systematic prioritisation and allocative criteria. It is speculative to ask whether this would have been possible, or how long it would have taken. In practice, the decision was made, instead, to couple electrification to

the clinics building programme, which was proceeding area by area, and which had already developed ways of working. These included a style of negotiation between local communities and responsible local authorities, and attempts to maximise community participation in controlling (and taking part in) the building process, facilitated by IDT field agents and professional consultants.

The decision to couple electrification to the building team's operations therefore limited the questions of where, and when, initial electrification initiatives should proceed — and partly resolved the bulleted questions above (negotiations, planning, legitimacy) since these had already been partially encountered by the building team. It provided a pragmatic way forward.

One effect of this decision was a bifurcation of effort within the electrification programme, during 1993:

(a) a specific electrification project for Kangwane clinics (later extended to clinics in Venda) — on quite a small scale, serving almost as a pilot project for the RAPS electrification aspects, and

(b) concurrent development of much broader IDT policy towards rural electrification support, including national negotiations with major potential role-players such as Eskom, DBSA and the National Electrification Forum.

These could of course complement each other, in the longer term, but only limited complementarity was apparent in 1993.

9.3 Eskom involvement

During 1993, one reason why there was limited complementarity between the wider IDT electrification policy approach and the more specific projects may lie in the fact that Eskom did not have electricity supply rights in Kangwane or Venda, and were therefore not organisationally involved in these "pilot" projects.

This points to an area for concerned comment:- It is not clear that Eskom has developed greater capacity for RAPS implementation, during 1993, as a result of the IDT programme. Rather, there has been a sense of Eskom hanging back, at an ***operational*** level, or of being delayed by not articulating with concrete IDT-sponsored initiatives. This contrasts with one of the "hopes" expressed at the beginning of this section, namely that the participation of utilities (particularly Eskom, with its strong technical and organisational capacity) would help to promote technical expertise and standards in the RAPS supply industry. This may still come about, but to date has happened only to a limited extent, independently of the IDT programme.

On the other hand, at an ***electrification policy*** level, the presence of the IDT programme has (a) helped to keep RAPS electrification firmly, or at least visibly, on Eskom's agenda, and (b) has probably helped to clarify Eskom's consideration of rural electrification strategies. At this important level there has been considerable convergence between the way IDT has spoken about the electrification of rural community institutions and similar expressions of support and prioritisation from Eskom. Further, the place for external grant funding or external concessionary loan finance to offset the "uneconomic" portion of rural electrification initiatives has had strong presence in rural electrification policy discussions, within Eskom and more widely.

Nonetheless, during 1993, there is a broad impression that all this remained largely policy talk — perhaps appropriately so under the shifting circumstances of political transition, but perhaps also missing some opportunities for practical preparatory developments within Eskom. To give some specific examples (again focusing on the RAPS side):

1) Amongst Eskom regional distributors (who carry out Eskom electrification) there seemed to be a perception that RAPS policy statements from Megawatt Park, and more generally statements about electrifying rural community facilities, did not (a) amount to practical targets, and (b) were not backed up by operational support and directives from central Eskom management.

2) Amongst particular regional distributors, or particular Eskom regional staff, who were committed to include RAPS in rural electrification drives, no clear forward direction was established during 1993 as a result of Eskom-IDT negotiations.

3) The Eskom-convened "RAPS Technical Working Group" seemed to operate in a bit of a vacuum, although there were moves from Eskom management to strengthen the status and responsibilities of this group, partly by bringing it within Distribution Technology's committee structure.

4) The main fairly large-scale RAPS/rural electrification initiative within Eskom (for developing areas) promised to come from the Durban distributor, independently of the IDT programme. But later in 1993 the Eskom funding for this was apparently clarified downwards, and this initiative may proceed in 1994 in closer liaison with IDT.

5) Otherwise, most of Eskom's concrete RAPS activities were absorbed in a handful of continuing demonstration projects (mainly schools) and in a troublesome contract to provide off-grid power to a small number of commercial farmers in the Northern Cape, at the tail end of a state-subsidised grid extension scheme to this border area. Both the Northern Cape Distributor and RAPS staff in Eskom's Technology and Research Investigations division became embroiled in remedying the fall-out from an irregular preferential contract here, involving unproven technology.

Eskom is a powerful and capable organisation. This observation could be challenged only as an understatement: Eskom is one of the world's largest electricity utilities, generates more than half of Africa's electricity (at internationally low prices), accesses national and international capital on very good terms, and formulates policies with a view to economic and political vitality, both nationally and in the wider Southern African region. Eskom management, in recent years, has been politically proactive, while assumptive South African political policy-makers have shown a keen sense that Eskom's strength is an asset to be harnessed for national and political gains; common interests have been established.

Eskom's economic strength (compared, for example, with other Southern African utilities) allows for involvement in RAPS electrification. At the same time, Eskom's political prominence, as actor or asset, encourages a social welfare conscience. This combination could lead to an expectation that Eskom can be the most powerful and effective vehicle in Southern Africa for supporting socially-responsive off-grid electrification programmes. However, this would require preparatory work by Eskom which has so far been only patchy. For example, as far as is known, Eskom has not

yet organised any internal RAPS training for regional distributors; financing mechanisms (e.g. through the Eskom RAPS tariff) have been revised but not yet applied in any significant way; technical support for RAPS within Eskom is rather marginalised and uncoordinated. Some observers suggest a clearer *practical* commitment from top Eskom management will be required to get the ball rolling successfully. Others regret that closer practical cooperation between IDT and Eskom was not achieved in 1993, since this might have hastened the process. The prospects still lie ahead, however, for 1994 and beyond.

9.4 Other electricity utilities

Insufficient current information has been collected to comment usefully on the scope for other electricity utilities in South Africa to embark on sustainable RAPS electrification, as part of their business. A general point can be made: the "homeland" utilities in many cases have had more exposure to rural electrification in underdeveloped areas, and more exposure to the context of rural development in these areas, than Eskom. In some parts of the country served by these utilities, significant RAPS electrification projects have taken place over time, most often, however, drawing on external private sector contractors, and not always well regulated. BECOR (Bophuthatswana) has considerable strength and size; TESCOR (Transkei) is judged to have above-average capacity for RAPS electrification; VECOR (Venda), now the Venda National Development Corporation: Electricity Division, has been unusually vigorous in domestic rural electrification. One opinion is that the skills and experience which have been built up will be likely to survive restructuring of the electricity distribution industry in South Africa. If so, this would help to justify IDT's willingness to allocate both grant-funding and responsibility for future upkeep and maintenance to several of these utilities and/or allied service departments.

Another opinion is that sustainability (e.g. maintenance responsibilities) would be more secure if underwritten by large national institutions in the country, including Eskom, rather than regional utilities or service departments which probably face greater change through restructuring.

During 1993, however, it was hardly a practical possibility that Eskom would accept unpredictable responsibilities for the maintenance of RAPS installations in areas where Eskom was not currently operating.

One would expect changes in the electricity distribution industry to include (a) rationalisation of the countless municipal and other local authorities presently responsible (alongside Eskom and other utilities) for electricity supplies across the country, and (b) a rationalised regional framework, with greater devolution of responsibilities and powers to a small number of regional distribution authorities across the country, into which existing players may merge. The former is most significant for urban electrification. The latter would probably be most significant for rural electrification. The most appropriate level for coordinated RAPS electrification activities in future may be within such regional distribution authorities (rather than national). Some, by virtue of location, would doubtless be more active in RAPS than others — as at present.

9.5 The role of RAPS consultants

EDG (the Energy and Development Group) have been appointed as RAPS consultants within the IDT clinics electrification programme to carry out a number of tasks, partly on IDT request, partly on EDG initiation. EDG's role has probably not been typical of private-interest consultants. For example, EDG entered this field from a public-

interest background, played a part in helping to formulate programme direction, undertook some preparatory tasks for which they were not appointed, and in the course of their approved appointments have performed a large amount of "background" work, which will hopefully serve future developments in RAPS electrification of rural community institutions.

At one stage, when observers were still considering the possibility of a systematic nationwide approach to electrification of rural clinics, some opinions expressed by professional engineers were that IDT should seek comprehensive project-management of at least the RAPS component of the programme. The organisational and engineering challenges, and the potential scale of the programme, required experienced professional management, backed by the scale of project management resources available from large engineering consultancies. Alternatively (from other commentators) Eskom should project-manage the programme. However, as sketched above, Eskom was neither prepared to project-manage RAPS electrification across the country, nor seriously requested to do so. It was probably also felt that conventional engineering consultancies would lack experience in RAPS electrification, would cross-cut existing utility responsibilities for grid electrification aspects, might be insensitive to complex non-engineering political and development issues, and would charge professional fees (reducing the proportion of IDT funding that would reach the intended beneficiaries).

The overheads of professional fees could be expected to be greater in such a spread-out project as RAPS electrification of rural clinics.

Working more closely with the torn fabric of service delivery in poverty-stricken rural areas, it is likely that IDT staff had greater awareness of and concern for the non-engineering barriers to implementation at this level — from local government departments, down to community level, amid widespread political upheaval. From this perspective, the potential advantages of strong, external engineering contractors "going ahead" would probably be reduced: engineering supply could be resolved, but other infrastructural weaknesses would remain unresolved.

Having decided *not* to proceed nationwide, but progressively by region, IDT appointed EDG to negotiate with service departments and Kescor in Kangwane, to investigate clinics' energy needs and to come up with preliminary designs and budget costs for RAPS systems to serve clinics which would not be grid-electrified. As part of this phase, EDG also negotiated a contract for technical testing of PV-powered vaccine refrigerators. There was initial reluctance, on IDT's part, to pay for refrigerator testing, one argument being that industry should cover the costs of such activities, but the testing went ahead and became an important element in the necessary preparation for sound design and specification for Kangwane clinics.

Some uncertainty about how to value such preparatory activities must have arisen from **uncertainty about the scope of RAPS clinic electrification.** This was a danger in a regional piecemeal approach. The preparatory overheads entailed in EDG's design and specification for ten Kangwane clinics (later five) were proportionally quite high, unless this work could be viewed as a pilot project which would establish procedures replicable elsewhere. Secondly, a source of remaining uncertainty was **who would be responsible for management and implementation** of RAPS electrification projects, first in Kangwane and subsequently elsewhere. This, together with the question of who would be responsible for maintenance, impacted on the preliminary stages. To give an illustration, if Eskom would be responsible for maintenance of systems, then Eskom would want to be involved in and satisfied with the design,

while if EDG were to be appointed consultants and project managers, then they would wish to ensure the reliability of installed systems themselves. In the end, EDG were appointed as consultants and project managers for Kangwane and Venda, with 1-year responsibility for maintenance supervision. It is not yet clear what procedures will be followed elsewhere, as the programme continues in other regions.

A small, specialist consulting group such as EDG probably does not have the capacity for nationwide project management, and is best equipped for investigating initial options and setting examples of how to proceed. The experience gained by EDG should place them in a favourable position for managing similar projects elsewhere, within their staff and time constraints, but if the scale of RAPS electrification develops as anticipated, then other consultants or utilities will need to take project management functions. A question, then, is to what extent the preparatory work conducted by EDG will be transferrable to other agencies.

The relatively slow pace of developments during 1993 did not bring this question to the fore, and it is likely to become a more pressing practical question in 1994.

9.5 Technical design

At this stage, the technical design for RAPS systems for Kangwane and Venda clinics still remains to be finalised, implemented and monitored. An unusual degree of detailed design specification went into the tender documents. It is likely that not all tenders will comply with the tender specifications, and that every tender will have distinct features affecting the final installed design/s. However, it was apparently EDG's intention to be quite strongly prescriptive, partly to guard against common weaknesses in PV design and installation, partly to provide detailed site-specific requirements, and partly because of the spectre of consultants' responsibility for successful performance.

In respect of compliance with existing national standards (to the extent that these are applicable) the technical specification is conservative, but in some aspects it does not appear conservative. For example, lighting levels and the overall system energy-supply capacity show cost-consciousness, while a novel configuration for sharing surplus power between otherwise separate PV systems for critical clinic loads (mainly the vaccine refrigerator) and other loads has been strongly recommended in the project specifications, although not tested before in the field. A particular make of battery has been specified, although it is left up to tenderers to indicate how the batteries should be regulated. In these latter respects, the technical specification might be considered bold.

Irrespective of this, the performance of installed systems should be carefully monitored and assessed. There is great potential value in the development of sound, detailed technical specifications, and strong efforts should be made to confirm the validity and value of the work which has gone into the design specifications for Kangwane and Venda clinics, and to indicate adjustments if required. On-site monitoring is difficult, however, as remote monitoring systems are usually less reliable than the RAPS systems they monitor. Plans for monitoring are not clear at this stage.

9.6 The tender process

The large amount of work which was devoted to preparation of detailed tender documents for RAPS systems at a few clinics provides some insight into why this had never been done before in South Africa. Conversely, the amount of time required was

partly due to the fact it had not been done before. Tender specifications for similar ventures in the past have been much less comprehensive, or absent.

There are advantages and disadvantages in a thorough open tender process. Advantages include greater fairness to competing companies and the potential benefit to the client of being able to select the best tender/s. Providing contractual responsibilities are clearly specified, this should lead to clear understandings and provide a framework for ensuring that these responsibilities are satisfied. Disadvantages are mainly to do with the amount of time and preparatory work entailed — not only for the consultants preparing tender documents, but also for tendering companies.

As far as can be judged, the spirit in which private sector RAPS supply companies approached this laborious process was generous and participative. Despite the relatively small size of the initial contracts for RAPS electrification of Kangwane and Venda clinics, almost all the major RAPS suppliers found it possible to submit tenders, some complying fully with the requirements, others partially. (At least one major supplier, with overseas principals, unfortunately found the timing a constraint, and did not tender on this account.) In the same way that the consultants' work could be justified, not by the scale of the Kangwane/Venda contracts alone but by the contribution which it could make to a wider programme, it seems that supplier companies were equally mindful of future expanded opportunities, and went to considerable effort to respond constructively and creditably to the tender enquiry.

To streamline the process in future expanded projects, it would not be surprising if some consultants / project managers consider *nominating* RAPS supply contractors, rather than going through an open tender process in every case. Again there would be advantages and disadvantages. Productive and trusted relationships can be established, economies in time, economies of scale. A company or a small number of companies which gain such trust could build up capacity in expectation of steady contracts, and build up experience. Disadvantages include the tendency for exclusion of potentially competitive suppliers, reduced innovation, possibly less transparency. It is suggested that the development of the local RAPS supply industry is still at a stage where open tendering would be more productive. It encourages wider participation and therefore has a public-interest benefit in stimulating broad-based capacity in the industry. It should be remembered that RAPS electrification is fundamentally decentralised and therefore (especially with respect to installation, maintenance and training) requires sufficient capacity in localised regions.

The relatively short time between inclusion of Venda in the present clinic electrification contract, and putting the contract out to tender, indicates that once the groundwork has been done, a thorough tender process for new projects need not be unduly time-consuming. A few months is a small portion of the expected lifetime of rural RAPS installations.

Of particular interest in the next year or two will be the approach adopted by utilities, assuming they proceed with RAPS projects on a significant scale. Will they put out open tender enquiries? Will they instead maintain a list of approved suppliers (this appears an Eskom preference)? Will they place bulk orders on components, and how would this affect the operations of private-sector RAPS suppliers? To what extent will they make use of external consultants or internal expertise for project management and design? In the near future, one can probably expect an interesting variety of approaches. It will probably take some time before the most workable patterns emerge. These will also be contingent on changes in government, the electricity

distribution industry, the status of present grant and loan funders and the possibilities of further national and international investment programmes for rural development.

9.7 Cost-benefit appraisal

This section is not an appraisal of the costs and benefits of providing electricity to clinics in Venda and Kangwane, but rather a broader discussion about the need for cost-benefit appraisal.

It is relatively easy to establish initial supply costs for electrification of rural community facilities. Future costs are admittedly less certain (e.g. in the RAPS case, the costs associated with maintenance, battery replacements, etc). It is *much* more difficult, however, to assess expected benefits. This is because it is not really known what the outcomes will be, and the benefits associated with the outcomes are likely to be diffuse, complex, and very difficult to quantify.

Yet policies for rational support of rural electrification do require an adequate understanding of economic and social benefits, in relation to costs. Only in this way can well-founded choices be made about where to electrify, to what extent, and how to apportion support for electrification versus support for other services and development objectives.

Even in making the narrower decision about when to choose RAPS or grid electrification options, costs of supply are not an adequate guide, since different benefit streams are likely.

Conventional prevailing approaches to the economic analysis of alternative energy projects, and of cross-sectoral investment alternatives, have tended to focus on what can be quantified, since other factors entail so much contestable judgement, and hence on financial cost comparisons. Fairly cumbersome adjustments may be made, where it is known or believed that market prices do not reflect true costs, due to market imperfections. But the evaluation of benefits largely remains an unopened book. Within a "market" paradigm, a conventional assumption is that "willingness to pay" is the best indicator of benefits. Those paying are assumed to be exercising their best judgement about what the outcomes will be worth to them.

There are obvious flaws in this approach to the appraisal of expected benefits, if applied to the provision of subsidised public services amid conditions of rural poverty and institutional weakness. For example, whose "willingness to pay" is considered? Community members are typically neither private consumers in a money market nor organised in a collective which has control over budgets to spend on freely substitutable alternative community services. Only some services may be obtainable at a given time, and subsidy support for some services may not be available for other investments or expenditures which the community might otherwise prioritise. If, on the other hand, willingness to pay is identified at, say, the level of regional service-provision authorities, decisions will surely reflect a balance of complex considerations (including departmental budgets which may be non-substitutable across departments and a host of political and operational factors) which do not really provide a measure of end-use benefits to recipients of services — particularly if the authorities are not responsive to or accountable to community-level demands. In either case, where external subsidy and grant support enter the picture, the "price" to be paid cannot realistically be separated from the element of subsidy. This dogma for equating benefits with "willingness to pay" therefore cannot provide guidance on setting subsidy levels, which is one of the main questions in the provision of services for the rural poor.

There are many other flaws and limitations in this approach, from a theoretical point of view, which need not be argued here. It is more interesting to ask whether the underlying notion is useful or suggestive. It is not a simplistic notion. It is hypothetical, in that it would presuppose the existence of coherent demand structures whereby recipients of benefits *could* choose how to spend money. In this case, subject to limitations, end-user expectations of benefits might be reflected in the choices made.

Applied to the provision of rural services, this notion therefore would seem to boil down to quite a different point: that benefits are difficult to assess by policy-makers, and that local demand structures need to be built up so that allocative decisions will be a better reflection of the value which recipients assign to alternatives.

Interestingly, two quite different approaches have been canvassed in national and international debates and (to some extent) practical initiatives in South Africa. One approach is to say that subsidy and grant assistance is most effective and least distorting if it goes to the pockets of final recipients as directly as possible. They are then able to choose how to spend, and unwarranted appropriations of subsidy and grant finance by bureaucracies, industry, etc, are reduced. Perhaps one could identify IDT's drought relief programme as an approximation to this approach. By contrast, the present dominant trend in South African electrification policy is to recommend a flat-rate national (or regional) tariff structure, for all domestic consumers (urban or rural), set with the aim of overall cost-recovery within the utility but powerful cross-subsidisation, internal to the electricity sector. Where socially warranted, further external capital subsidy would be supplied to offset the "non-economic portion" of electrification schemes, especially for rural community institutions. In this version, the tariff cross-subsidy is not transparent to users, and non-substitutable across different sectors (for example, it is not available instead for water supply), while additional capital subsidies (e.g. from IDT grant funding) require a number of allocative decisions about how much, where, how much for electricity versus other services. . . bringing back the vexed social cost-benefit questions in sharp relief.

Such unanswered questions may lead to a prevalence of central political decision-making in coming years, including sectoral allocations and regional allocations.

Within the IDT clinics electrification programme, so far, a somewhat mixed model has been followed. Elements have included:

1. Central decision-making (by IDT) about how much money is allocated for electrification support, nationwide.
2. A decision that rural community facilities and in particular clinics are top of the rural electrification priority list.
3. A framework for dividing up regional allocations according to quantified scale of needs (e.g. numbers of schools and clinics, socio-economic poverty indicators), but conditioned in practice by ability to spend the money in different regions.
4. Negotiations with regional health authorities, and utilities, regarding their priorities, plans and supply capacities.
5. Attachment to the clinics building programme, which is said to have operated more closely with community participants.
6. Targeted appraisals of electricity and energy needs at clinics, through discussions with clinic staff and health authorities.
7. Appraisals, within IDT, of the relative importance of electricity supply in different service sectors (e.g. for clinics, for schools).

8. A degree of devolution of allocative powers, e.g. in the form of block funding to utilities, and the proposal from IDT's Education portfolio that Regional Trusts should prioritise schools to be electrified and decide the value of electrification versus other areas for expenditure.

Notably, this mixed approach has reflected (a) an absence of national government structures for making policy and allocative decisions in this terrain, (b) the practical difficulties of negotiating with fragmented regional structures, (c) limited opportunities for investigating and responding to local-level demands, except through existing service structures, and (d) an uncertainty, pointing forwards, about the ability of regional service departments and electricity supply authorities to take on the difficult tasks of integrated allocative decisions to promote welfare and development.

If nothing else, this discussion has highlighted a relationship between the abstract idea of cost-benefit appraisals, and the embeddedness of this vital question in political and economic structures. There is scope for improved cost-benefit *methodology* and a requirement for *empirical information* (what happens after electrification?) to inform cost-benefit decisions. However, the *application of cost-benefit appraisals* in rural electrification is not abstract but is embedded in economic and political decision making at many levels, and therefore will strongly reflect the constitution of national, regional and local government, community representation, utility policies and practices, and (in general) the distribution of power and resources.

10 Guidelines and recommendations

One of the intentions of this study was to draw out guidelines from experience in the IDT clinics electrification programme (during 1993) which might assist the replication of similar ventures in the future. It is tempting to say that it is too early to do so. Broad procedures have not yet been fully established and/or put to practical test. However, a great deal of preparatory, formative and policy-directed work was accomplished during 1993 by the various participants. Brief notes are made below about aspects which have potential for replication and extension into the future.

10.1 Possible examples for replication

Several aspects of the pilot RAPS electrification projects in Venda and Kangwane may set examples for possible replication.

- The **liaison process** (between IDT, the RAPS consultants, local government service departments and utilities and health care staff) seems to have been fairly open and thorough. This contrasts with a number of past projects, and sets a useful example.

- In Venda particularly, the collaboration between IDT field agents and RAPS consultants was productive. Well-trained and motivated **development workers operating at a local level** can provide a valuable interface between consultants, local staff and communities, and local government departments. This model could usefully be replicated, though it is likely that it would take different form in different localities.

- The **energy needs assessment** process, although quite sharply targeted and perhaps constrained by the projected electrification task, provided an example which was probably more consultative and more detailed than in most other previous RAPS electrification projects.

- It is worth noting that good collaborative liaison can have **spin-offs**. For example, as a result of the pilot project in Venda, keen interest has been shown by the utility in developing its RAPS capacity, both for supply and maintenance. Enquiries have been made, parallel to the clinics project, about lists of RAPS contractors and possibilities for linking RAPS water pumping with community employment projects. Even tightly defined RAPS electrification projects can spawn other developments through consultation and participation by local service structures.

- The **technical preparation** conducted by EDG should have benefits extending beyond the present pilot projects. Included here are the testing of physical components (in particular, local DC vaccine refrigerators); the international advice which EDG sought in preparing preliminary designs; investigations into lighting options for rural community facilities; and several other design-related activities.

- Many of the detailed design investigations became incorporated in the **technical specifications for tender**. These specifications should have considerable scope for beneficial replication, providing they are placed by IDT in the public domain. Such specifications should nonetheless be regarded as evolving, and open to modifications, additions and subtractions in the light of experience.

- The **format** and setting-out of **contractual responsibilities in the tender enquiry** provides a useful and replicable model, following the General Conditions of Contract for use in connection with Electrical and Mechanical Engineering Work, as prepared by the South African Association of Consulting Engineers.

- The **form of contract**, with a 1-year defects liability period and a modest hold-over portion of payment, needs to be monitored in practice but establishes a possible model for maintaining a level of contractual responsibility, by the supplier, for performance to specifications while not imposing unduly onerous conditions which might lead to higher prices.

- The **tendering process** (including preliminary discussions with RAPS supplier companies, and site visits to clinics for potential tenderers) has probably helped to establish greater communication, sense of common purpose and professionalism in the local RAPS industry.

- It is too early to say whether models for **training**, at different levels, will be successful and replicable, but it is likely that preparatory work conducted by EDG will be a valuable resource for future projects.

- Project management by consultants is one model amongst several for making the implementation links between IDT grant finance and the installation of RAPS systems at clinics. So far it is the only one which has been tried out. It has entailed a learning curve for IDT, which was not well prepared for **handling professional contracts** of this nature in an efficient and routine manner. If this model for implementation continues, the gains should be replicable.

- Allied to this is the impression that IDT is **severely understaffed** for the massive responsibilities and challenges assumed by the organisation. Although it is likely, over the next few years, that IDT will no longer bear such heavy

unaided responsibilities for health, education, agriculture, employment creation, drought relief, etc, it is also likely that IDT will professionalise and staff its various functions in a more sustainable way.

- It remains difficult to say, at this point, whether successful models have been established between IDT and utilities — and within utilities — for sustainable RAPS electrification of rural community facilities.

- It is also difficult to judge at this stage whether the present arrangements for ongoing maintenance and running costs of RAPS systems at clinics in Kangwane and Venda will be robust, and whether wider plans for establishing one or more "Joint Maintenance Funds" will be effective.

Some broader points can also be raised here:

- It is possible that the technological focus on PV electricity supply may have de-prioritised non-electric aspects of clinic and clinic staff's energy needs. In future projects, ideally, an integrated energy needs appraisal would include **strategies to improve the provision of thermal fuels**, since the provision of RAPS electricity does not help here. (Appendix A reports staff disappointment that a PV system would not provide electricity for cooking — their main hope.) There is the wider question of whether bottled gas, rather than RAPS electricity, should be taken as a serious competitor to PV electricity for powering clinic (and staff) refrigerators; a well-organised secure supply could also help meet cooking and heating needs; moreover, reliable transport services, which are needed for secure fuel deliveries, could have multiple benefits to clinics and their surrounding communities, particularly if organised in a way which combines two-way transport of goods and passengers (including extension personnel). However, this would require imagination, rationalisation, adequate budgets for diesel mechanics, vehicles and transport fuel, and outstanding management. A less ambitious goal would be to give attention to the supply of gas and paraffin at the same time as specifying RAPS electrification — from the energy end-users' perspectives, they cannot be separated, without de-prioritising non-electric energy needs.

- There is also some doubt about whether water supply needs were given sufficiently thorough attention in the pilot projects. In Kangwane, the observation that lack of accessible groundwater in most localities put aside the question of energy for water pumping, should clearly not be generalised. For beneficial replicability, the energy needs assessment process for clinics (and more broadly for community services) must surely target **water pumping as a standing priority**. A difficulty occurs where different government departments, or different wings of a welfare and development programme, are responsible for water, versus energy and other services.

- IDT's decision to reformulate a national programme of implementation into a **region-by-region approach** was driven by practical obstacles, including the time-consuming nature of negotiations in each region, the lack of national infrastructure for rural electrification, and lack of knowledge about needs, plans and capacity in each region so that it was not feasible to gain a prior picture of overall scope of the clinics electrification programme. It also reflected area-specificity of clinic building team operations (including their attempts to interact more directly with recipient community structures). It is clear that some of the fragmentation, variable access and variations in regional planning and servicing

capacities are a consequence of apartheid homeland policies. However, it is likely that these aspects will have a momentum which continues beyond the forthcoming national and regional elections. Moreover, the size of the country is a lasting factor. For these reasons, **it is likely that a regional division of grant-funding support and regional devolution of allocation and implementation responsibilities will continue**, hopefully backed by coherent national policies. IDT's suggested criteria for inter-region allocations, although based on objective criteria of scale of needs, are unlikely to survive new consolidated regional power constituencies, unless IDT is allowed to maintain its measure of independence in making such allocations (which is probably unlikely). The strategy of addressing regional needs in **programmatic units large enough for mobilising major finance, but small enough for effective management** (e.g. a cluster of magisterial districts) seems reasonable, but other financial, organisational and political factors may cross-cut this proposal.

- The question "Who owns the money?" is likely to come under review. IDT's stated policy, that its assets are targeted to assist the poorest of the poor (irrespective of geographical or political affiliation within South Africa), will probably not survive a new national reconstruction and development programme which, in becoming pragmatic, will probably look for differentiated welfare and development strategies, rather than a residual category of programmatic relief for the sectors of the population who have been most dispossessed by apartheid. IDT's mandate (and funding) were set by a non-representative government looking backwards over its shoulder in haste, while a future government is likely to look forwards in haste, reversing the previous decision that IDT allocations would be independent of state control. This is of course speculative, but if it happens it could change "ownership" of IDT assets in both senses — who controls the assets, and who has rights to receive the benefits. The rural electrification support programme within IDT has invested in this uncertain future by putting forward quite a robust agenda. Electricity is not a basic need for the poorest of the poor, but electrification of rural community facilities can possibly bring benefits to the rural poor while also representing visible progress. It is likely that the principles of **grant-finance to offset non-economic portions of rural electrification** will survive for some years ahead, intermeshed with loan finance and internal utility finance for cost-recovery portions of investment in rural electricity infrastructure. However, the locus of control of assets for such grant-finance may well move out of IDT's ambit, partially or completely, for example into a National Electrification Fund subject to strong state control. Policies for poverty-alleviating applications of grant-finance, through high leverage in marginal non-economic electrification situations (a high card in IDT's present approach), may become stretched to other purposes if control over grant-finance and concessionary loan finance reverts to central policy makers with other pressing agendas. In this case, much will depend on the interests represented by central policy-makers. However, IDT, together with Eskom and other contributors to policy debate, have established a **fairly strong rationale for selective electrification of rural community facilities**, and irrespective of ownership and control of assets it is likely that this argument will stay on the agenda, inbetween improbable hopes ("all rural schools will be electrified") and urban biases.

10.2 Specific recommendations

These are not intended to be comprehensive. Instead, a few specific suggestions are made.

Technical aspects

1. The technical performance of clinic RAPS systems (and appliances) should be monitored after installation. One suggestion is that a repeatable acceptance test should be conducted at time of hand-over and again after a year. If a sufficiently informative acceptance test procedure can be devised, this should be useful (and efficient). However it is recommended that at least one clinic installation should be monitored in more detail — as simply as possible, but on a continuous basis, to establish energy utilisation and supply, and the utilisation and performance of appliances. A great deal of work has been invested in the design specifications for these systems, and it would be a loss if adequate technical assessment of the design does not take place. It may be possible to commission an Eskom RAPS specialist in Nelspruit to undertake such monitoring at one of the Kangwane installations.

2. In view of the difficulties of on-site monitoring, it is recommended that an identical system should be installed at the Silverton Renewable Energy Demonstration Centre, operated with controlled loading, and monitored thoroughly. This would also help to serve informational, promotion and training purposes. There are current discussions about upgrading demonstration PV systems at the REDC, and this would be a good way of exposing interested parties to a well-engineered PV system, which has important development and welfare applications.

3. IDT should place the specifications which EDG developed for Kangwane and Venda clinics in the public realm, in support of broader efforts to develop standard specifications for RAPS systems.

Social delivery

4. Participative follow-up enquiries are recommended to find out how clinic staff perceive the benefits and possible deficiencies of installed RAPS systems, in relation to their work and domestic well-being. These enquiries should not be restricted to the use of electricity, but should include other fuel use and also non-energy aspects of their work and domestic context. This will help an appraisal of how far the electrical supply has brought benefits, relative to other concerns.

5. Liaison should be maintained quite regularly with local government service departments and utilities, in an organised way. There must be continuity after initial implementation.

Planning

6. Resources should be devoted to serious cost-benefit evaluation of electrifying rural community facilities.

7. There should be sufficient coordination between agencies responsible for health, education, water supply, employment creation, etc, to allow a coordinated

approach to electrification of rural community facilities, in particular where rural grid electrification schemes can serve multiple institutional (and private) consumers.

8. More reliable and comprehensive databases should be developed to map existing rural community facilities and their functions throughout the country.

9. An integrated developmental approach should be promoted, which weighs up the appropriate balance between different service needs in a rural community and which takes account of economic production opportunities. Supply-focused programmes (such as rural electrification) should be proactive in seeking a more integrated developmental approach and should seek to strengthen local-level demand structures.

Utility recommendations

10. Rationalisation of the electricity distribution industry should seek to strengthen regional capacity for rural electrification. Preparations for greater involvement in RAPS and grid supply for rural community facilities should be premised on a drive towards such rationalisation.

11. Transfer of RAPS knowledge to electricity utilities should be promoted through selective appointments of specialist RAPS consultants or contractors to work alongside utility staff on initial RAPS projects.

12. Utilities should provide technical RAPS training to appropriate staff.

13. If utilities are prepared to take a more integrated approach to rural energy service provision, they should appoint or train the equivalent of "field agents" with local knowledge of development issues.

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Appendix A

Kangwane clinics: activities and energy needs assessment

Prepared by Sarah Ward, Energy for Development Research Centre
November 1993

1. Aims

A 5 day period was spent visiting some of the clinics in Kangwane (18 - 22 October) and speaking to staff and others associated with the clinics with the aim of gaining a better understanding of:

- the general development needs of the clinics
- the specific energy needs of clinics
- the role the clinics play in the broader community

This work is intended to contribute to better integrated development planning, and more specifically, energy planning for the area. It was also hoped that some ongoing links could be established with the clinics and community members so that monitoring can be ongoing.

2. General

2.1 Scope

Owing to the limited period of time (5 weekdays), I concentrated my visits to the clinics in the Nkomazi Region (the middle portion of Kangwane - see map). This area falls under the jurisdiction of the Shongwe Hospital and is also known as the Shongwe Ward. In this Ward there are:

20 full clinics (full time staff who work Mon-Sat morning and do night calls)
18 day clinics (staffed once a week by nursing staff and/or doctor)
2 24hour clinics (these have observation beds and are both electrified)
9 care groups

I visited Shongwe Hospital, 5 full clinics (Jeppe's Rust, Mgobodi, Skhwahlane, Sihlangu, Mbusini), one day clinic in operation (Ndindini - this will become a full clinic soon), one 24 hour clinic (Mangweni - where I spent an evening, night and morning) and a couple of care groups. I visited one full clinic in the Themba Ward (Luphisi). I also spoke to the architect responsible for some of the full and day clinic upgrades.

2.2 Staffing

The most common staffing compliment for full clinics is one nursing sister, one nursing assistant, a cleaner, a gardener and a night watchman armed with a torch! The hospital superintendent, Dr Mark Barry and clinics matron Sister Ivy Sebia, pointed out that they are generally understaffed and that there is a high turnover of staff, particularly at the non-electrified clinics and at the more remote clinics.

2.3 Notes

The health system in the Shongwe Ward appears to be well organised, with established systems for the distribution of water, gas and paraffin to the clinics; good contact with the hospital and ongoing programmes for nurses, care groups and care educators. However, there have been a number of armed robberies of clinics in the Ward (5 or 6 in the past 10 years) and these appear to be on the increase due to rising unemployment and the increasing number of AK47s coming across the Mozambican border since the end of the civil war. The consequences of this are discussed in more detail under point 4.

The intensity of work varies significantly between clinics, with clinics seeing between 100 and 700 cases per month.

It should be noted that this report is *context specific* to the Shongwe Ward and the comments and conclusions cannot simply be extrapolated to the whole of Kangwane (the following section describes some of the specific conditions of the Shongwe Ward). In addition, the period of time spent in the area was short, giving only an outsider's snapshot view of the situation. Follow up visits, a longer time period and more active participation by the users would be necessary for a more comprehensive assessment.

3. Existing situation

Refer to section 6.7.1 of the main report. There is currently a building programme in progress as part of the IDT programme: extensions/new buildings are being built at some of the full clinics and multipurpose rooms at day clinics (day clinics are located in areas where there are very few facilities of any kind; the multipurpose rooms can therefore be used by the community for a variety of purposes when the clinic is not in operation).

3.1 Clinic energy

In brief the "energy situation" in the non-electrified full clinics is as follows:

- each clinic has a radiophone working on solar power, however most of these function only during the day as the storage batteries do not work
- each clinic has a fridge (household type) which runs off gas supplied by the hospital (2 x 19kg bottles - the hospital wants to increase this to 3)
- lighting is usually by one gas lamp, paraffin lamps and candles
- heating water and sterilising instruments is done on gas cookers (1x9kg bottles)

3.2 Staff housing and energy issues

The situation in the nurses housing varied from clinic to clinic. The nursing sister at Luphisi clinic had her own generator for TV and lights, others had car batteries for powering TVs (Jeppes Rust). Most nurses used paraffin lamps for lighting in their homes, some however only used candles - the reason for this at the Luphisi clinic was that there had been no paraffin delivered for the last 2 months.

Nursing staff were generally dissatisfied with the standard of housing provided at the clinics (except at the electrified clinic), usually due to the low level of service provision especially in the more remote clinics. Nursing staff are reliant on TV (most own a colour TV) and radio, but TVs are difficult to power and in many areas only Swazi radio is accessible.

There appears to be a predominance of older single nursing staff, usually widowed, at the more remote clinics. Of the clinics I visited, none were occupied by families, and, if it was possible, most nurses preferred to live at home (away from the clinic) as

> "those houses are too small for a whole family".

Dr Barry, the hospital superintendent also said that

> "clinic nurses work under very adverse conditions and should expect a comfortable house with running water and so on"

Although there is a feeling amongst the health administrators that a blind eye should be turned to nursing staff using the clinic facilities such as the fridge and gas cooker in order to supplement their living conditions as a perk to their jobs, this is discouraged in the Shongwe Ward. The reason for this was to encourage the independence of the nursing staff so that at retirement age a nurse did not find herself too reliant on the clinic and its facilities. The nursing staff, however, complained of the expense of having to pay for gas and paraffin and seemed quite dissatisfied with the arrangement. One sister said that she was shocked to hear that even at the electrified clinics nurses had to pay for electricity in the nurses houses. There were a number of other indications that the staff thought that electricity would be far cheaper than gas and paraffin.

4. Shongwe Ward - some context issues

There was a marked difference in the attitudes and perceptions of nursing staff at the different clinics. In my opinion these were attributable to three major factors:

a. the relative remoteness of the clinic
b. the level of service provision (this includes lighting - inside and outside and water) in the clinic and in the nurses housing
c. whether the clinic or the staff had been subject to robberies

These are discussed below.

a. Staff in the more remote clinics (Mbuzini in particular which is 40 km from the hospital and 2 km from the Mozambican border) were most dissatisfied with their posts. These clinics also tended to have a lower level of service provision than others. The staff felt they were in "forgotten areas" which no one cared about and as a nursing sister at Mbuzini said,

> "They only send the *mokoto* [the old] here"

Generally other nurses agreed that this was one of the worst postings and few younger nurses would accept or stay in such a posting as

> "you can do nothing there".

TV and radio reception were also extremely poor in this area. Generally, staff are very dependent on TV and radio for entertainment and most staff owned a colour TV.

b. The difference between the attitudes of staff in the electrified (24 hour) clinic at Mangweni and those of the non-electrified clinics was very apparent. The former seemed relatively happy with their jobs and in fact

made it quite clear that electricity made their jobs immeasurably more pleasant (this clinic is also on a tar road and has good security - these are important contributing factors). As a nurse at the electrified clinic said:

"Once you've worked in a clinic with electricity you can never go to a clinic without"

A nurse who had just completed a 6 week relief period at the remote Luphisi clinic commented when the resident nurses returned,

"Never again will I work at a clinic with these terrible facilities".

Nurses are trained in hospitals with electricity; quite frequently their homes to which they either return nightly if they do not live in the nurses accommodation or on weekends, are electrified and therefore their capacity to live and work without electricity is low. The lack of other services, particularly water, also created a lot of dissatisfaction as did the general condition and access to services of the nurses housing.

c. The clinics are perceived as sources of cash (R 3.00 is collected from each patient) and as undefended. The most recent robbery took place in July this year at night on the Mgobode clinic (a full clinic), the nurse being made to open the door under the pretext that a woman was in labour. This incident seems to have been "the straw that broke the camel's back" as all nursing staff at the full clinics are consequently refusing to do night calls - for how long or until what demands are met appeared to be still under debate, but these certainly involve security (of which security lighting would be an important component) as well as the meeting of other needs such as better remuneration for night work, improved facilities, transport and provision of services (particularly water and electricity). There seems to be a general resistance to doing night calls whatever the conditions because of the nuisance value and danger, and that night community needs should be met by the 24 hour clinics. The Mgobode clinic has only recently begun functioning again (October) with new nursing staff; the staff are refusing to stay in the nurses housing.

5. Role of the clinic in the community and related needs

5.1 Clinic Committee

Each clinic has a committee consisting of more prominent members of the community, eg. headmasters of schools. These committees are active and were engaged in trying to resolve the issue of security for the clinics.

5.2 Care groups

Nine care groups have been set up in the Shongwe Ward supported by 4 care educators linked to the hospital. The care groups are groups of women from the community who take some responsibility for looking after children needing special care (as a result of kwashiorkor or marasmus). These children are passed into their care by the hospital, the clinic staff hold a clinic for them every two weeks. The care groups are not only concerned with health matters but also with informal income creation. They make wire fencing, grass mats and sew sheets. Medicine Sans Frontiers (MSF) (contact: Jeanne Louis Haye) have built a number of rondavel type structures for their use. These structures are usually located in the grounds of the clinic. They could be used at night for adult education classes but would then require

lighting. I am not sure where the care groups get finance to buy materials but it appears that MSF subsidise them.

5.3 Vegetable garden projects

The chief Matron at the hospital, Marjorie Themba, is responsible for a vegetable gardening project at the clinics as part of a nutrition programme. I think that members of the community can be allocated plots and use the clinic water but I do not know much more about it. Many clinics struggle for water supply for the clinics so this would be a limitation.

5.4 Relationship with schools

The clinics I visited had a very limited relationship with the schools in the area, although as one nurse said,

"we are supposed to work with the schools but there is no time"

It appears that clinic facilities, even if electrified, are rarely if ever used by the schools (Mgobode).

However, this appears to be quite different in the areas where there are only day clinics (and generally fewer facilities all round). The building programme here is aimed at building a multi-purpose room which can be used by the clinic, the school or for other community activities. The architect involved in this programme said that one of the day clinics had been completely taken over by the school which was refusing access to it by visiting day clinic staff!

I visited one primary school which was next door to the Mgobode clinic. They expressed an urgent need for electricity and would be interested in receiving solar power when the Mgobode clinic receives power. Two teachers and the vice head said they would use electricity for lighting for evening classes (for the office and some class rooms), audio-visual (videos) and computers (these would be provided by the Department). The Mgobode clinic has solar lighting in 2 of its buildings currently. The school staff were unsure whether they would be able to use these at night and had never asked. It seems that the clinics are regarded as being single function facilities.

5.5 Drought relief

The clinics were responsible for handing out drought relief food to families. The clinic facilities were explicitly not used for cooking. Instead all cooking took place outside in three legged pots over fires so that, as Matron Sebia said,

"women don't think they need sophisticated equipment to cook like this"

5.6 Pensions

It was mentioned at one of the clinics that the clinic grounds are used for handing out pensions on pension day.

5.7 Hospital calls

Relatives are permitted to use the clinic radiophone on certain days to find out about their relatives in hospital. It can also be used to call the police. This is a very valuable resource to the community.

6. Clinic and community needs

6.1 Security

This is a major concern in the area, for reasons already discussed. Certainly outside security lighting on the clinic, the nurses housing and the gate will improve the situation. Most staff are however of the opinion that this is not sufficient and that security guards are also required. Burglar proofing was also felt to be inadequate on the clinics and nurses houses.

6.2 Water

Water is a major problem and was brought up by almost all the clinic staff although the hospital superintendent said that it is not as great a problem in the Shongwe Ward as in the other wards. Piped water is often switched off/dries up and then the clinics are dependent on the hospital (?) tankers to fill the tanks. This is a prompt service but from the hospital's side is far too bureaucratic.

The new face brick clinics all have waterborne sewerage/flush toilets. Some of the clinics did not have sufficient water for them to function (most clinics still had their old pit latrines at the back, however I was not able to check this thoroughly). This seems an absurd over-specification in an area which experiences serious water shortages.

6.3 Electricity - clinic buildings and housing

All staff expressed a desire for interior lighting, but also for power for appliances, in particular radios and TVs.

Clinic staff generally use the clinic fridges to store their own food stuffs. This must be taken into account when replacing the clinic fridge with a vaccine fridge.[1]

Most staff expressed dissatisfaction that the solar supply could not be used for heating water and for cooking. These were in fact the first things they mentioned when discussing the benefits of receiving electricity. With regard to their housing it was related to cost of gas versus electricity and with regard to the clinics it was related to the ease of use particularly with regard to sterilising bowls and instruments.

Many of the clinic staff also mentioned the need for electronic suction machines as mouth suction carries the danger of infection by the Aids virus and the mechanical foot operated ones are inefficient. There may be other electronic medical equipment needed for similar reasons; this needs to be further researched.

Special lighting which can be moved (angle poise - preferably wall mounted, due to the lack of loose wires, or on a separate stand) and which is powerful was mentioned as being important for suturing and other detailed operations.

6.4 Paraffin and gas delivery

The unreliable delivery of paraffin to the clinics appeared to be a problem in some of the clinics, particularly the more remote ones. This did not seem to be a problem with gas deliveries. Possibly this was because the clinics used very little, if any,

[1] Glynn Morris, EDG, said it is planned to relocate old fridges in nurses' homes.

paraffin and it was mainly used in the nurses' houses for cooking and lighting. Consequently it tended to fall off the list of priorities.

6.5 Fridges

When Glynn Morris (EDG) tested the fridges in the clinics, they were almost invariably too hot — 10° instead of < 8°. The temperature measuring system in the clinics was insufficiently accurate.

6.6 Design of the buildings / heat

Some of the new clinic buildings are poorly positioned on site with the delivery rooms on the West! and some of the older buildings are poorly ventilated. Most clinic staff expressed a need for fans, particularly in the delivery rooms. (However in the Mboleni Region - west of Swaziland - staff expressed a need for heaters as the weather is colder here.)

6.7 Radio phones and telephones (RURTEL)

Some staff were dissatisfied with the radio phones while others had no problem with them. The extension of the RURTEL system to the clinics would improve the quality of home and work environments for the clinic staff, in terms of giving them better access to the hospital and the "outside world". It would however have to be installed so that it would not be subject to abuse. The staff at the electrified clinic, where there was an exchange telephone (Mangweni), complained that they always had a large unaccounted-for bill at the end of the month which they were responsible for paying.

6.8 Backup power for the electrified clinics

Staff at Mangweni 24-hour clinic said that electrical power was often off at the clinic for 8 to 12 hours. They appeared to have a very poor system of backup, relying only on candles for lighting and neighbourhood gas fridges when the power was off. They mentioned that a solar backup system would be good because then they could still run all their equipment. This clinic had the following equipment running on electricity: iron, 2 fans, suction machine, dental equipment, (laboratory and X-ray sections are to be opened), radio phone, ordinary phone and heaters. The nurses houses were also well equipped with hot water geysers.. . Sister Bettie who stayed in one of the houses had a colour TV, hifi, gas stove and she had just bought a 2-plate electric stove as she felt this would be cheaper than gas (she pays R 70.00 every 3 months to fill a 19kg bottle and about R 22.00 per month for electricity - before getting the electric stove, 2 fans and a large fridge). Well equipped!

6.9 Day clinics

The clinics matron commented that as the day clinics now have more facilities, they also have greater needs and services such as lighting, small refrigerators and radio phones should be installed. Lighting would also facilitate the use of the rooms by adults for night classes, meetings etc, in an area where there are few other facilities.

6.10 Maintenance

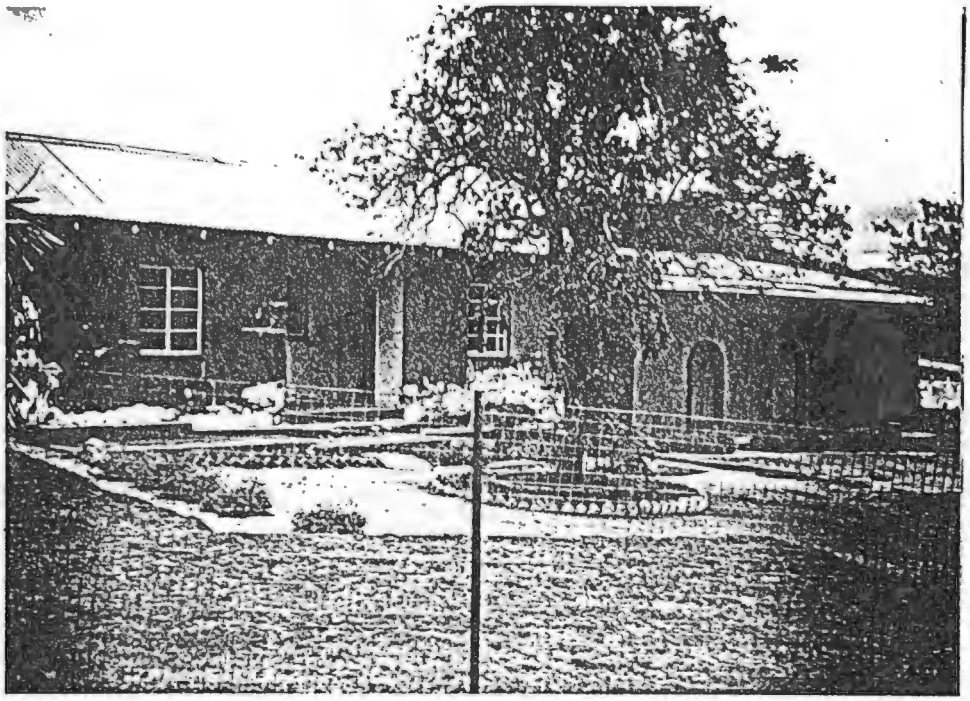
Clinic staff should be trained in basic maintenance of equipment. They should not, however, have to bear too much responsibility for this as they carry sufficient responsibility under difficult working conditions as it is. They might however gain a greater sense of control over their environment which would be positive.

7. Contacts

Kangwane Department of Health Dr Hoyland

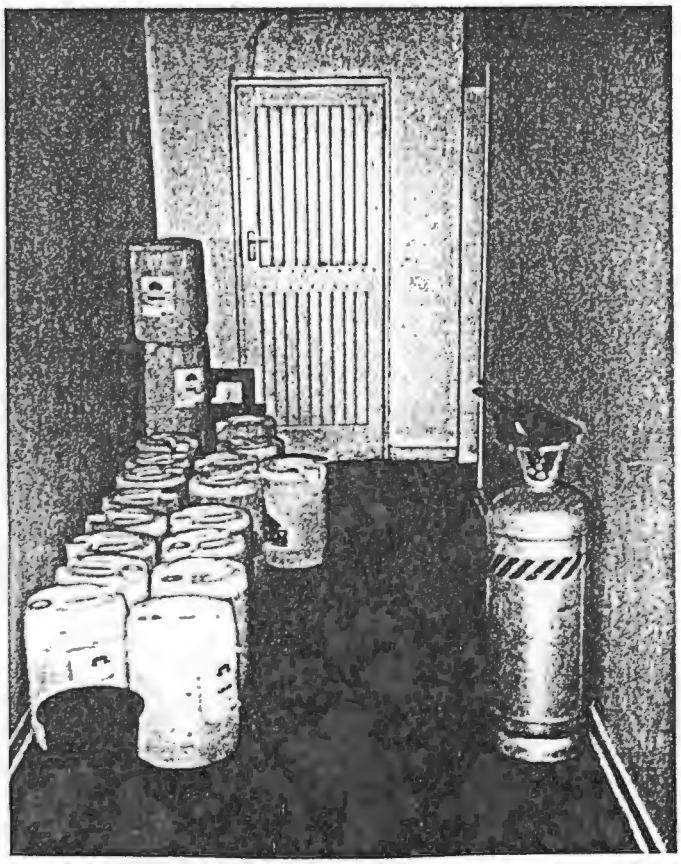
Shongwe Hospital -	superintendent	Dr Mark Barry
	clinics matron	Sister Ivy Sebia
	maintenance man	Adam Liebermann
	chief matron	Sister Majorie Themba
	travelling sister	Sister Machele
Clinics		
Jeppes Rust	nursing assistant	Phindile Mkosi
	sister	Susan Mkhatshwa
Sihlangu	sister	Jabu Khumalo
Skhwahlane	sister	Elizabeth Ntuli
Mbusini	sister	Alzina Ralebetse
	sister	Emma Mashabane
	assistant	Peggy Mazibuko
	cleaner	Bellina Mahlalela
Mgobodi	sister	Judith Labase
	sister	Mia Machele
	sister	Orfa Makatchwa
Mangweni (24 hour electrified clinic)		
	sister	Lucy Mahlalela
	sister	Bettie
		others...
Luphisi (Themba Ward)		
	sister	Lydia
Mgobodi Primary School		
	headmaster	F.R. Mbuli
	vice	Gideon Magagula
	Std 5 science teacher	M.C.Mnisi
	Std 3 teacher	E.P.Mathonsi

P.O.Box 366 Malelane 1320

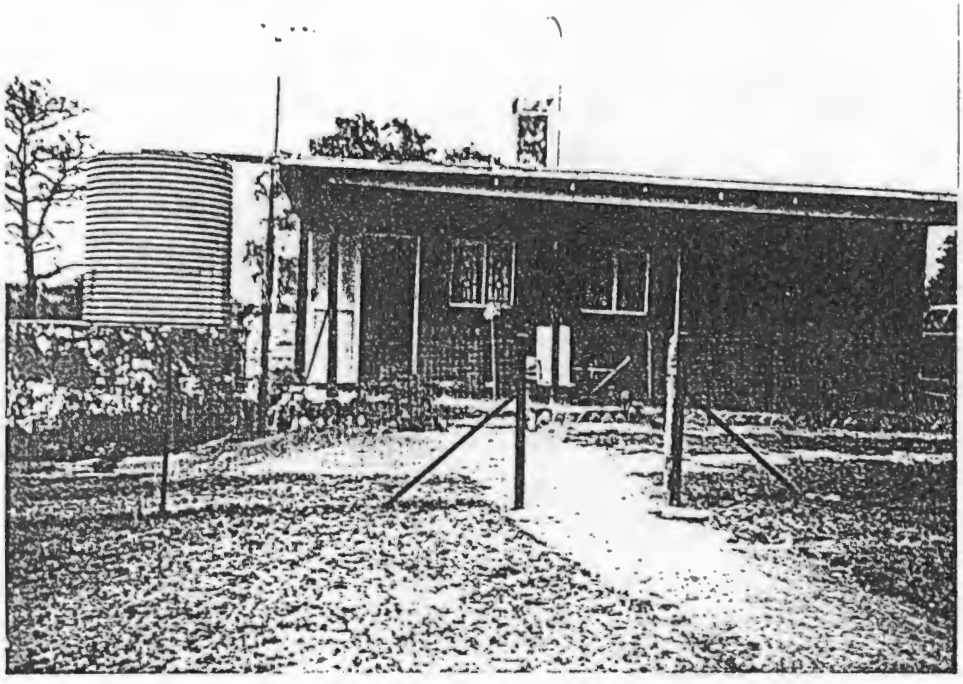


LUPHISI CLINIC
TEMBA WARD

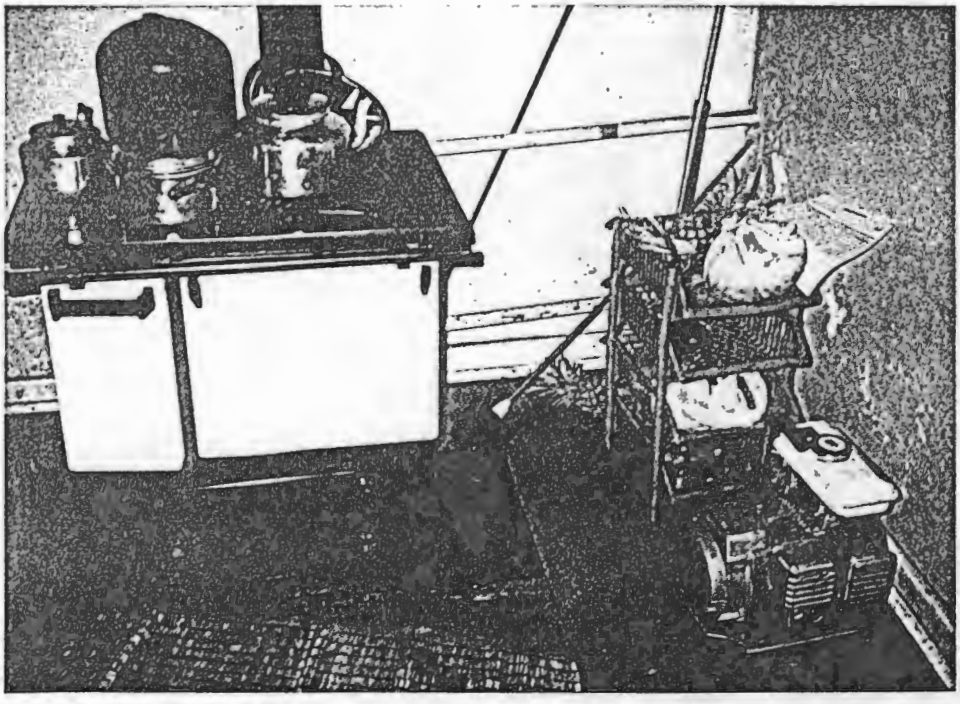
Clinic buildings: ante-natal and clinic



Clinic: 19kg gas bottle and water delivered in plastic drums



Nurses' home with TV aerial and geyser. The geyser is no longer used as the new kitchen stove is too small to heat it.



Nurse's house, Luphisi clinic

9 kg gas bottle, wood stove, generator for TV and lights.

In summer the wood stove is too hot for cooking — gas is preferred.

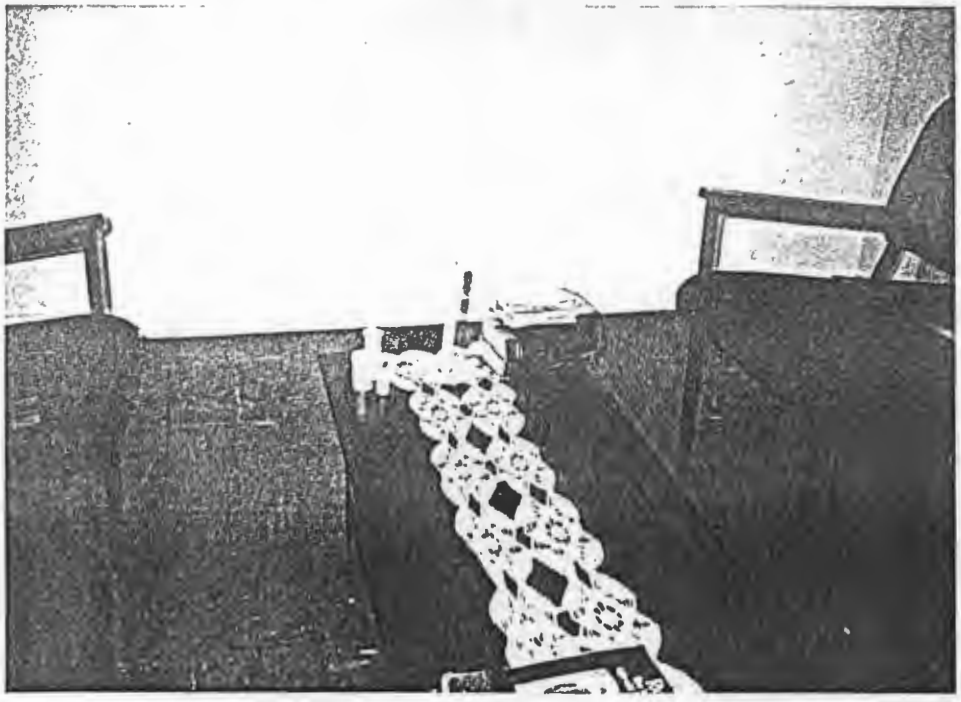
Sister Lydia

SHONGWE WARD
JEPPE'S RUST
CLINIC

Nurses' house.

Two primus stoves, gas stove, ironing board.

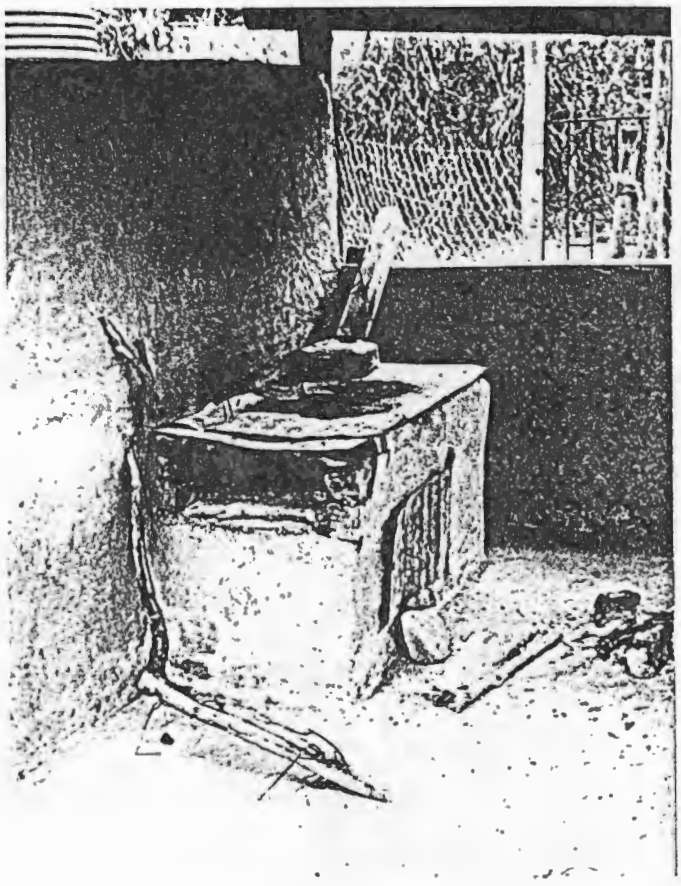
Sister Susan Mkhatshwa and clinic cleaner. They live together for safety and company.



This house used candles only for light.

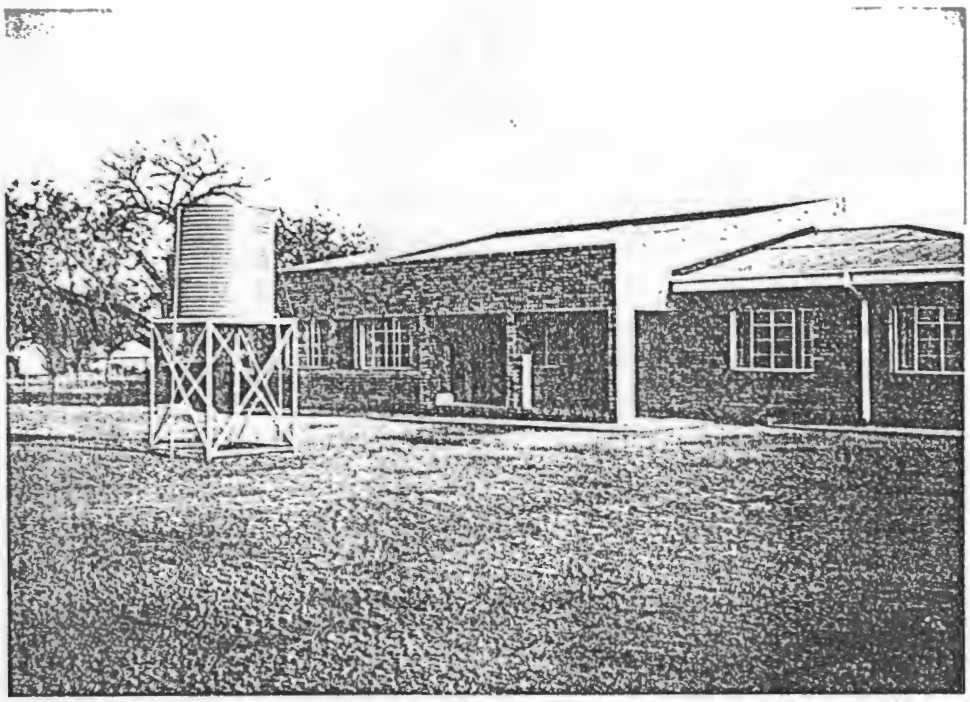
Jeppe's Rust Care Group Centre

Members of the care group making fencing and sewing sheets



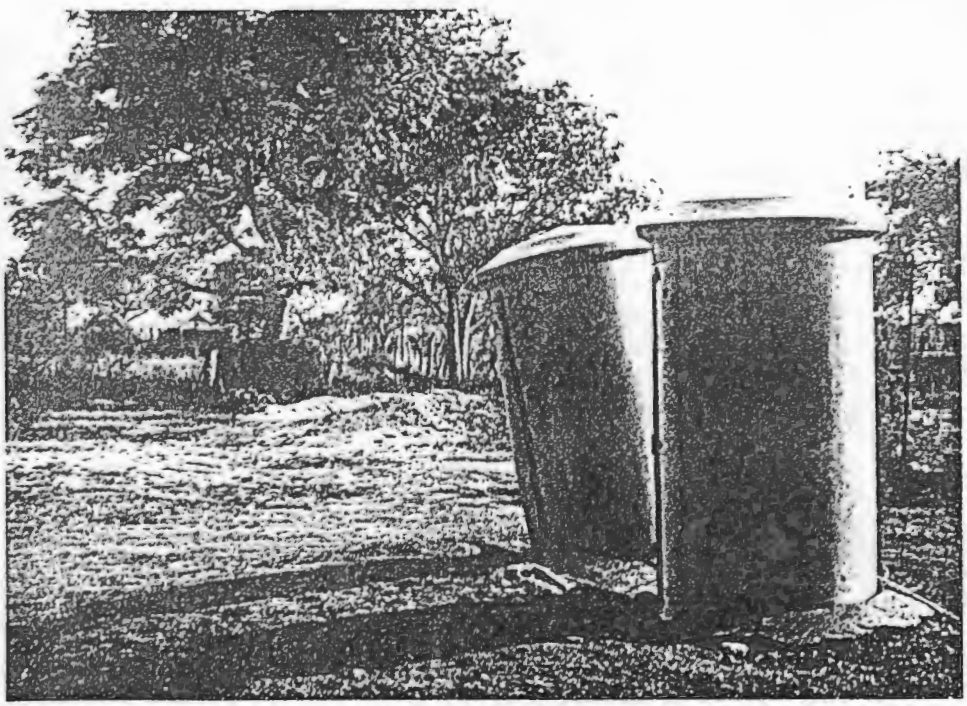
Care group stove with an oven. There is also a fire on the ground.

SKWAHLANE
CLINIC

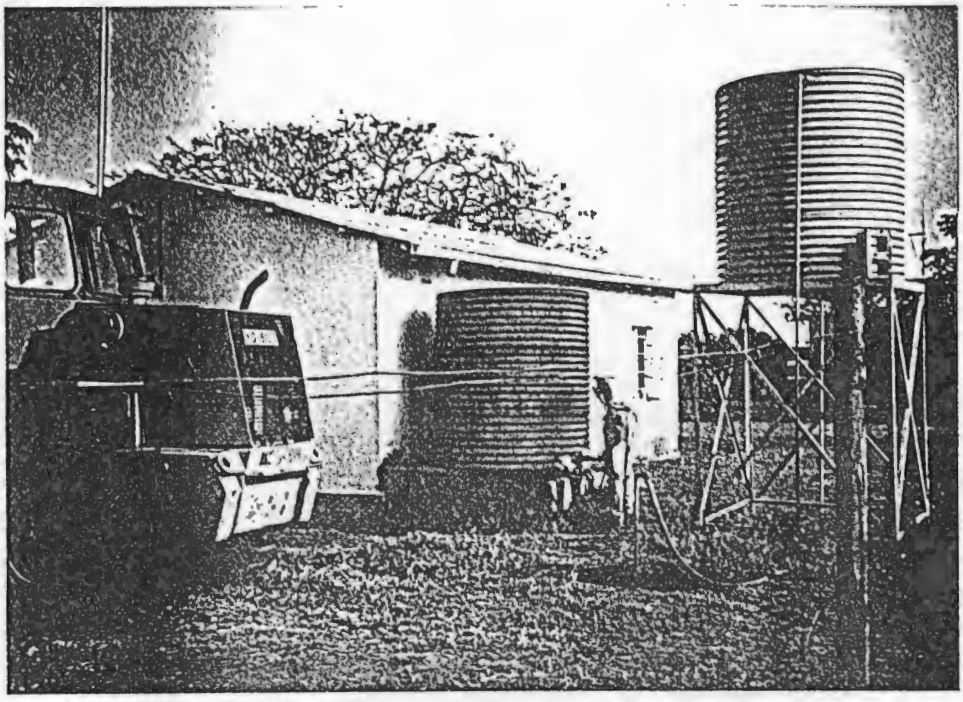


This is the standard design for the new clinics. Clinics are located to face the road — with little consideration of orientation towards the sun.

Each clinic has one or more water tanks.



Old disused pit toilets. The new clinics have flush toilets, although frequently there is no running water.

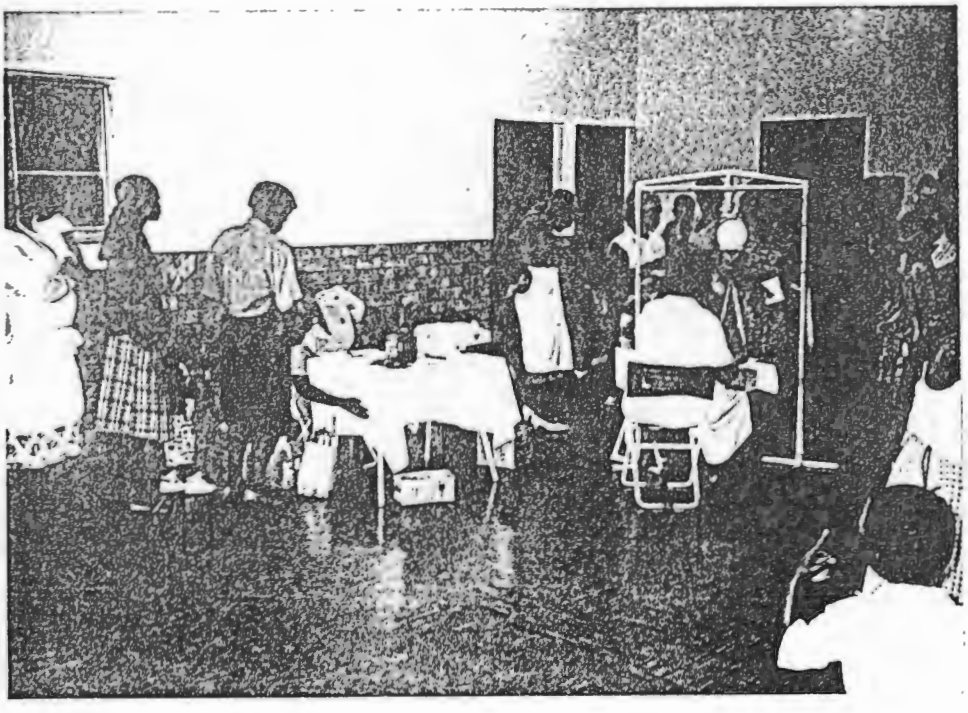


SIHLANGU
CLINIC

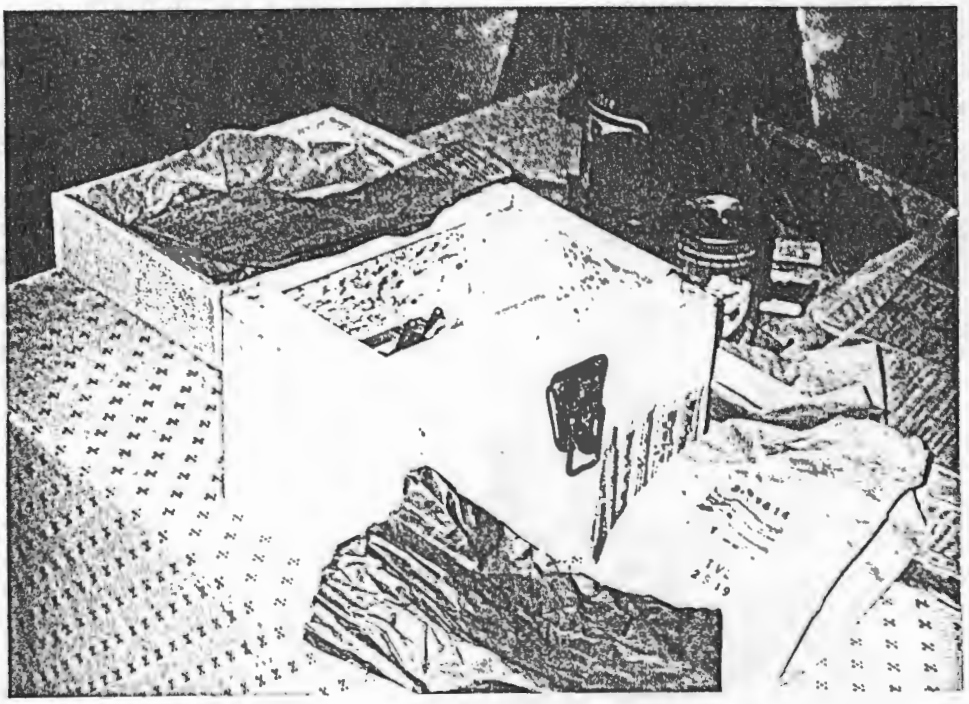
Tank taps were leaking. A new clinic building is under construction.

The nursing assistant using a radio phone.

NDINDINI (DAY) CLINIC (to become a full clinic)

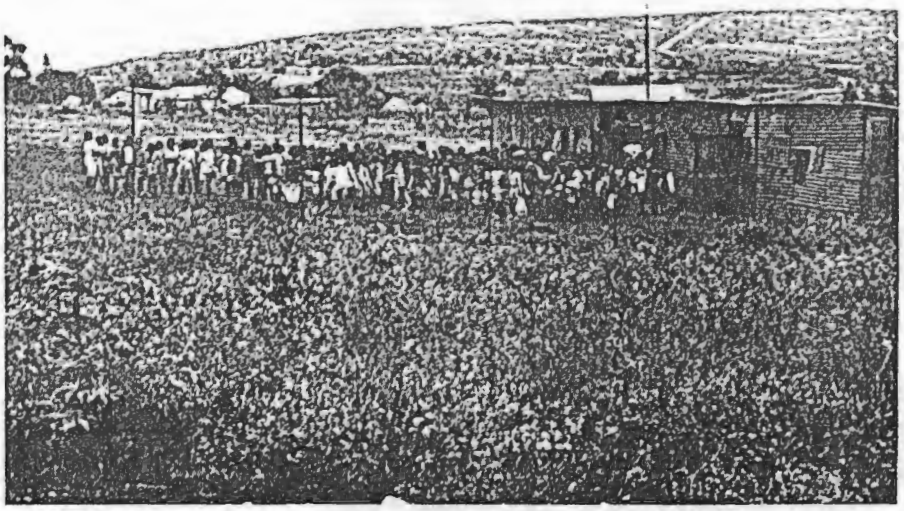


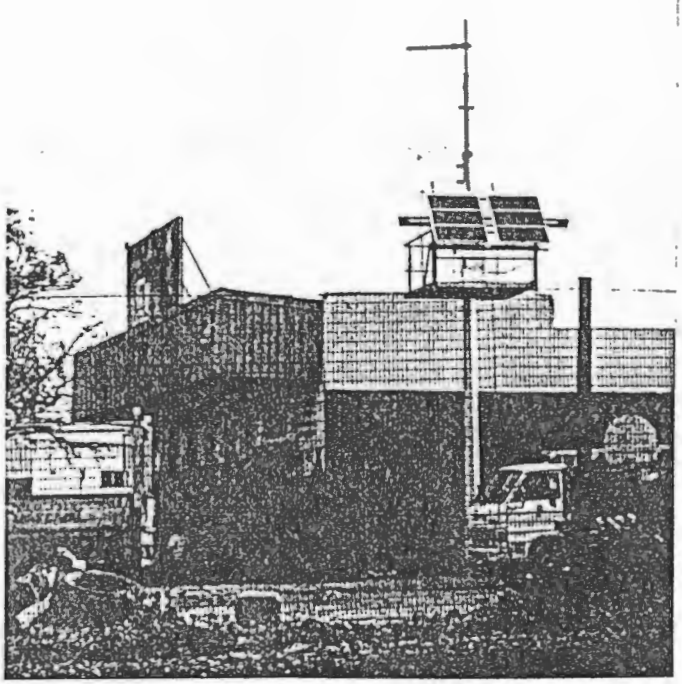
Weighing children, and immunisation.



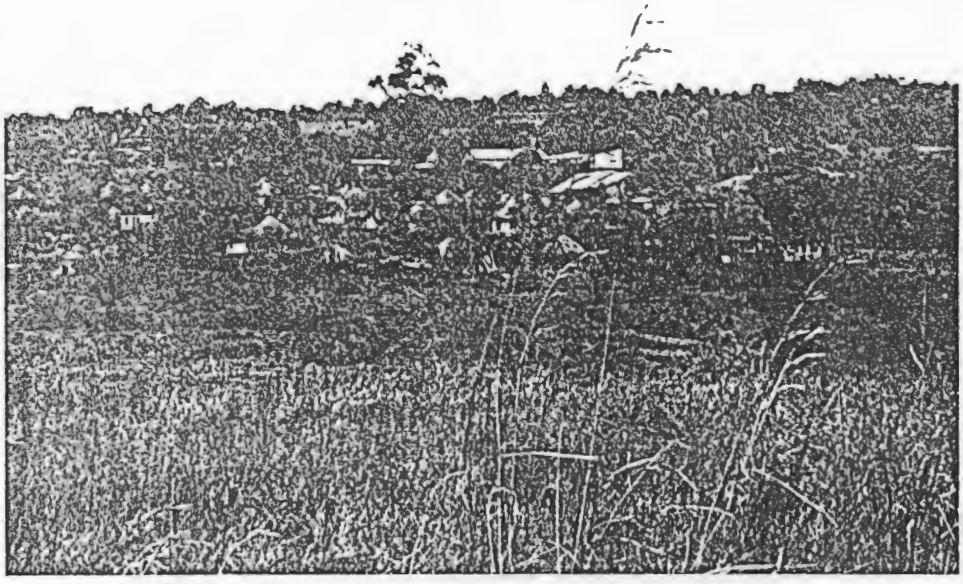
Cooler box for vaccines — travels from the hospital to the clinics. Contained two plastic cool blocks on which the vaccines were lying. The box remained open and well used for the two hours we were there.

Adjacent to the brand-new facebrick clinic is this primary school.

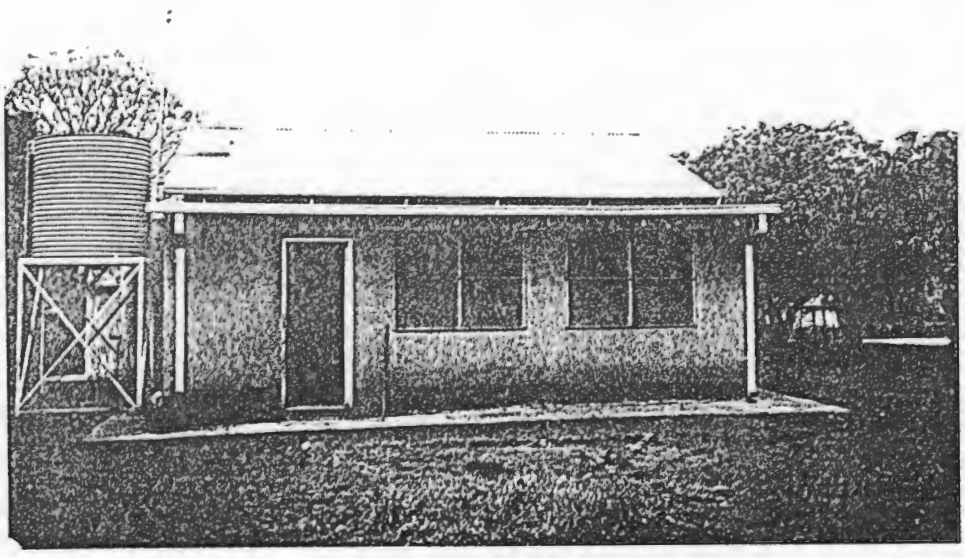




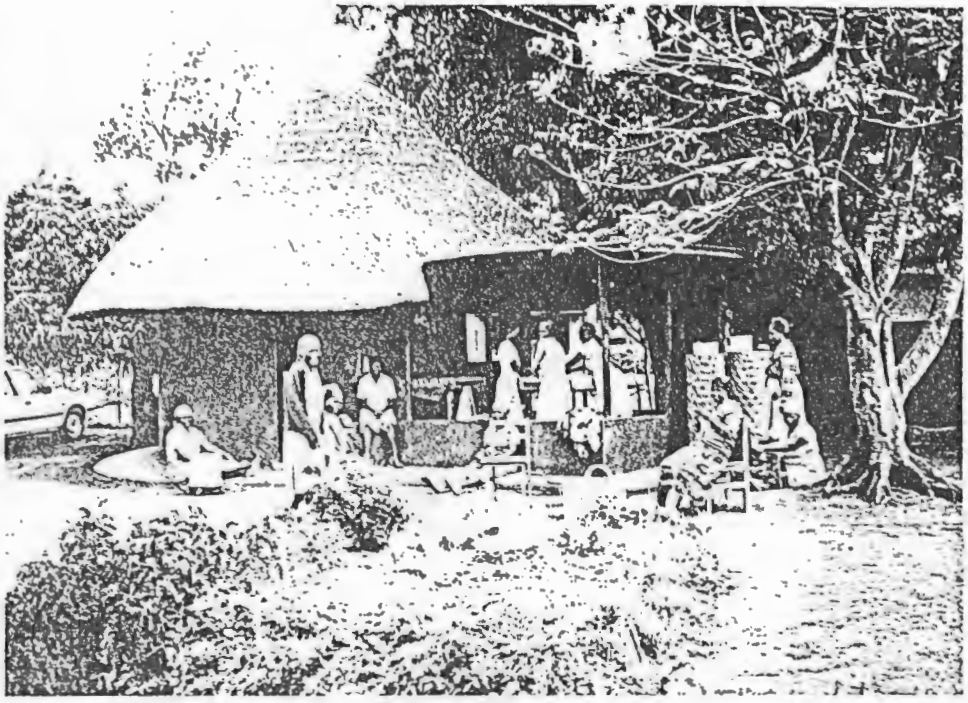
RURTEL, which is over the road from the clinic, at the local supermarket.



Mbusini Village, in the Lebombo hills close to the Mozambican border.



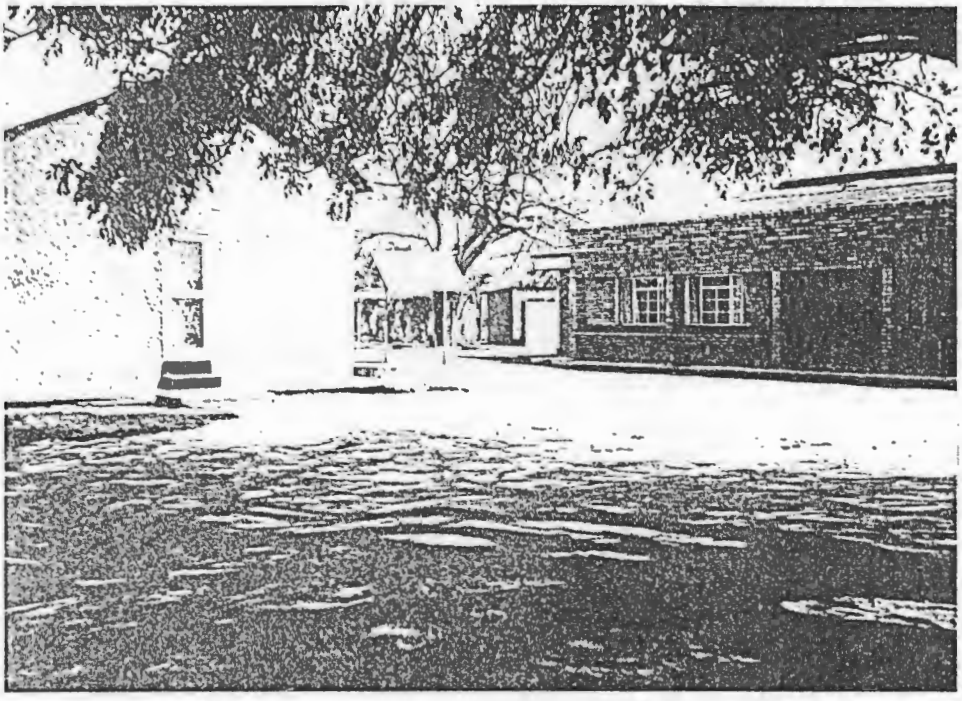
The clinic, with radio phone mast and water tank. A new building is to be built here.



Mbusini care group — making fencing and crotcheting

Staff at Mbusini clinic.

Sister Alzina Ralebetse, cleaner Bellina Mahlalela, assistant Peggy Mazibuko, Sister Emma Mashabane



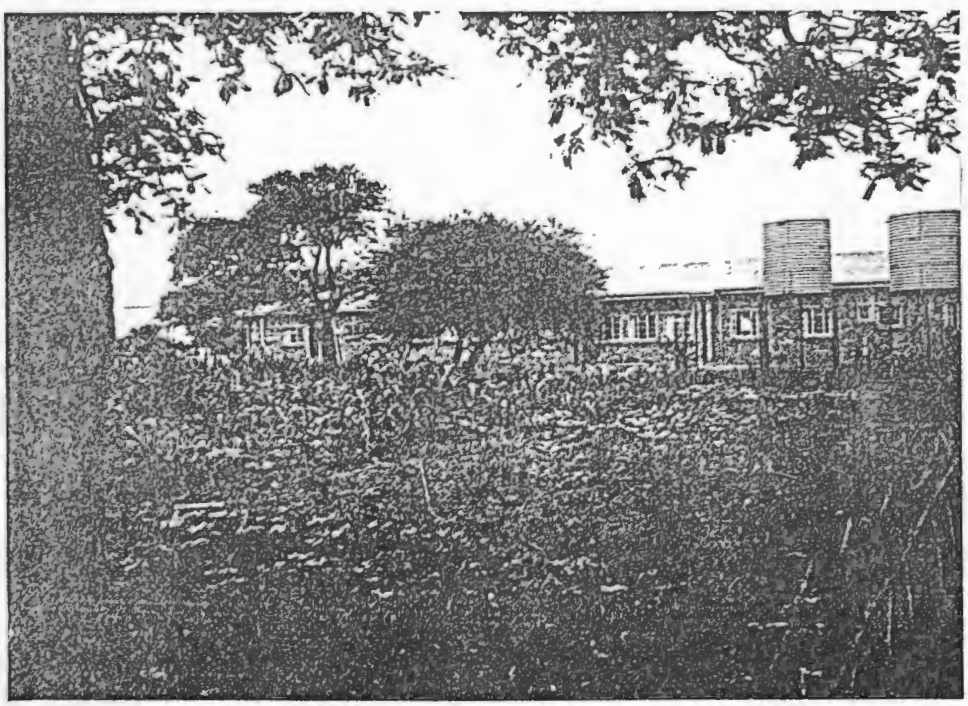
Old clinic, now nurses' house; solar panels powering two old clinic buildings; new clinic with no power as yet. The two nurses houses are not occupied at the moment because of the recent attack on the clinic.

Sister Mia Machele
Sister Judith Labase

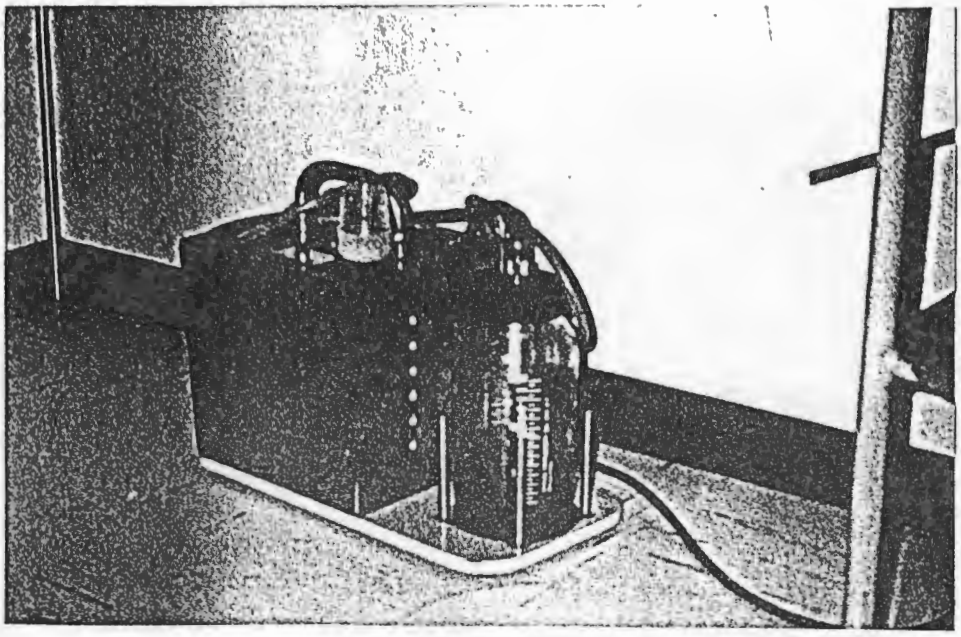
New care group building and cookhouse (rear) - unused except by security.

MANGWENI CLINIC

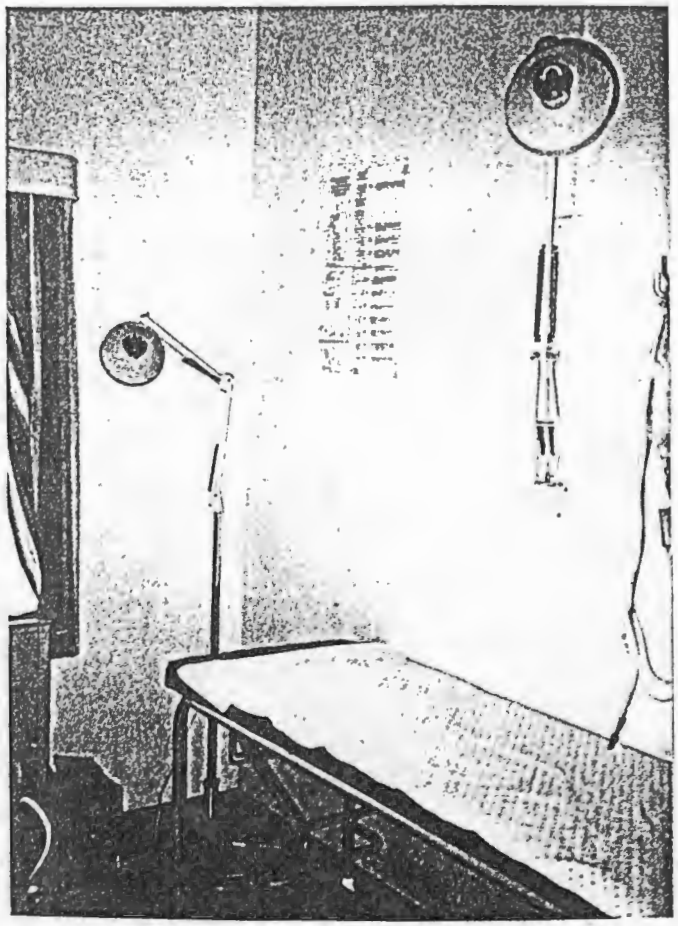
Electrified 24-hour clinic



Community vegetable garden at rear of clinic. This is a programme run by Chief Matron Marjorie Themba (Shongwe Hospital).



Electric suction machine.



Delivery room. Wall-mounted and mobile angle-poise lights.

Appendix B

Energy supply for off-grid clinics: the case for LPG (not solar)

The purpose of this discussion is to present an argument for *not* using photovoltaic electricity for energy needs in off-grid rural clinics. I will argue that LPG is cheaper, and more suitable, except for very specific electrical requirements (like telecommunications).

This analysis is in response to a request for the counter-argument against solar systems. The intention, however, is not to make a biased argument. By putting forward the case for LPG, it is hoped that energy supply decisions can be better-informed.

The value of supplying energy requirements through grid extension will not be discussed here. The discussion is limited to energy supply choices for small clinics which will not be served by the grid. In this case, the choice is between PV (or other Remote Area Power Supply) technology, and transported fuels such as LPG and paraffin. Additional fuels such as coal and wood may be relevant for meeting thermal needs; and solar water heaters might be considered for warm water. However, I will focus on what I think is the primary choice in terms of investment decisions, PV or LPG.

Substitutability

Virtually all energy services required in small rural clinics, and by clinic staff, can be met by LPG. The exceptions are as follows:

- **Telecommunications.** (Radio/telephone, TV).
  - In view of the high priority attached to telecommunications in remote areas, a strong argument can be made for having a reliable, limited electricity supply for this purpose. A small, dedicated PV system is most suitable.
- **Electric motors.**
  - Probably water-pumps are the only important higher-power application (at some clinics). Reliable water supply is crucial. In certain circumstances, a dedicated PV-pump may be most appropriate. This could be considered a separate, site-specific question.
  - Motors are required for compression refrigerators. However, satisfactory absorbtion refrigerators exist (meeting WHO standards) which do not require motors.
  - I don't know what priority would be attached to other (probably low-power) electric motor applications, e.g. in medical equipment, fans, etc.
- **Lighting.**
  - Electricity is not a requirement for lighting, but is more convenient for unattended lights (e.g. outdoor security lamps) and where high-quality directional task-lighting is required. This is probably a borderline area in the choice between electric and gas appliances. To attain comparable convenience with LPG may require special attention to the appliances used, but for general purposes, conventional gas lamps can be satisfactory. If lighting loads are unpredictable or vary a lot (over timespans greater than a week), PV supply can be very expensive, whereas LPG lighting can be adjusted to demand in a more economical way.

Just as there are energy applications which depend on electricity (e.g. telecommunications, electronics), there are applications for which RAPS electricity is definitely not suitable: any high-power heating applications. For these purposes — cooking, boiling water, heating water, space heating — LPG is however suitable and convenient. Lower-cost options may also exist, including local fuelwood. Even where this is the case, availability of LPG for

particular thermal energy requirements is convenient for clinic functions, and for resident staff.

(Solar water heaters could possibly reduce the costs of heating water, if bulk supplies at intermediate temperatures are used, or if solar-preheated water saves on fuel costs; but the priorities and economics would call for careful scrutiny.)

In summary:

- Only specific applications — primarily telecommunications — require electricity. Such specific needs can be met by a small, dedicated PV supply.
- All other energy needs can be met by LPG — possibly with some electric lighting as a borderline consideration. LPG use in clinics is widely reflected in existing practices. Reliability issues will de discussed below.
- In most off-grid clinics, a transported fuel will anyway be required for thermal applications (and these applications may have a high priority amongst staff). Where this is the case, it has a bearing on the cost comparison between PV and LPG supply, as fuel delivery costs will be incurred irrespective of PV supply, reducing the marginal costs of using LPG for virtually all energy needs.

LPG and paraffin

There is one important respect in which LPG and paraffin are not fully substitutable. Paraffin fridges, using wicks, require greater attention from the user and generally lack accurate thermostat control. For these reasons, paraffin fridges are a definite second choice, compared with LPG, for vaccine refrigeration in remote clinics.

Even so, the WHO appears to suggest that paraffin refrigerators could be preferable to solar fridges, if a reliable delivery infrastructure exists, and LPG is not available. In South Africa, however, there should be no reason why a local department of health (etc.) cannot access reliable LPG. Therefore the comparison between PV and transported fuels is based here on LPG — possibly higher cost than paraffin, but more suitable.

Reliability

The priority placed on reliable vaccine refrigeration is well documented, reflecting international attention and well-established temperature specifications for maintaining the potency of various vaccines. The priority placed on the reliability of other energy services (e.g. a radio link, ability to sterilise, emergency lighting, staff cooking, etc.) has not received as much attention. It may therefore be misguided to assume that vaccine refrigeration dominates the reliability question. A highly reliable vaccine refrigerator accompanied by unreliable energy supplies for other tasks might be a distortion of felt priorities and might incur distorted costs.

Reliability has many aspects. Before going further, two points can be raised:

a) unidentified performance failure, or damaging performance degradation, can have more serious consequences than known failure/degradation, provided

b) users have some ability to adapt.

In the context of clinic operations, it might be more damaging to proceed with impotent vaccination than to know that a batch of vaccines requires replacement before continuing. Or a back-up source of energy might be used, if available, if it is known that the first source has failed. Another typical case is where energy supply for some reason is inadequate to meet all needs, but lower priority needs can be delayed in order to maintain top-priority applications. These adaptive strategies are intrinsic to the question of reliability of end-use, and are served by:

- clear information about failure/degradation (and a knowledge of consequences)
- back-up options
- substitutability between low- and high-impact supply resources
- responsible action by users
- ability to communicate problems, for advice, assistance, repair, etc.

Reliability of end-use is therefore not a simple function of narrow technological reliability.

In the case of LPG-powered applications, it is useful to consider

- appliance reliability
- fuel supply reliability
- user effects on reliability, e.g. scope for constructive adaptation, scope for unintended use or misuse

Appliance reliability: I am not aware that LPG fridges need be less reliable than PV-powered fridges. However (as with electric fridges) a specialist design which meets WHO standards may be required in order to have a high probability of sustained operation in the correct temperature range. Two possible limitations, compared with an electric compressor fridge, are (i) restricted ability to freeze ice-packs in very hot ambient temperatures (above 35°C), and (ii) a danger of excessive cooling, due to the pilot flame, in very cold ambient temperatures. The main point is that there *are* gas fridges which meet WHO standards, at an international price which is competitive with PV fridges of equal standard. Some local reports of warm gas fridges, disguised by inaccurate thermometers, show mistaken settings or equipment selection, rather than an intrinsic limitation with LPG refrigeration. Other LPG appliances, such as lights and stoves, should not pose reliability concerns. Basic spare parts like mantles can be stocked and exchanged with little difficulty.

Fuel supply reliability: This is probably the major reliability concern for transported fuels at remote clinics. If there are situations where transport to a clinic *cannot* be regular (e.g. impassable roads), this would be a strong reason for avoiding reliance on transported fuels for critical tasks. In South Africa, I propose that such situations would be exceptional. In other more typical situations, where fairly regular road transport takes place, it is useful to consider reliability of delivery as an added cost, since it may require additional local organisation and resources to ensure sufficient regularity. In the comparison of PV and LPG refrigeration costs presented below, it is shown that a substantial premium can be added to basic LPG supply costs, while remaining cheaper than PV supply, and that this premium is notionally available to cover additional costs such as reliable organisation and maintenance of the delivery service. (A reliable delivery service for LPG enhances the reliability of all LPG applications at a clinic; there is clearly also scope for rationalisation of other services requiring transport of staff or delivery of materials.)

Compared with LPG, PV electricity supply requires more complex technology, entailing electronic control which, even if basic, is vulnerable to lightning damage, and batteries which require some maintenance and inevitably degrade.

Fuel supply reliability at a clinic also depends on ability to stock a secure reserve supply. In principle, this can be done at little added cost with LPG. In fact, energy storage with LPG is very cheap (compare batteries!) allowing for reduced frequency of deliveries, lower unit transport costs and cheap buffer back-up. In practice, two features are likely to predominate here: the security of funds for regular, adequate supply of LPG, and avoidance of unintended use of the local supply.

The security of future O&M funds must be considered a major concern in grant-funders' investment decisions, tending to push decisions in the direction of higher capital costs and lower recurrent costs, if these options can attain the same target. Unpacking this question slightly, it can be noted that

(i) recurrent costs with PV refrigeration are likely to be on a par with LPG refrigeration (battery replacement costs of about R2/day would be in the same region as LPG fuel costs; maintenance costs are unpredictable, but are unlikely to be less than LPG maintenance costs);

(ii) recurrent costs for PV systems are likely to be more lumpy, possibly an advantage in establishing a fund and administrative mechanism for meeting future costs;

(ii) security of future O&M funds depends on institutional arrangements, possibly more complex and uncontrollable in the case of LPG supply, since they are likely to entail multi-purpose structures and organisation at local department level; on the other hand, institutional arrangements for PV maintenance, while they could potentially be more isolated ("intact" from competing scarcities), have not yet been resolved and remain an intense concern.

User effects on reliability: An advantage of an LPG supply is that the fuel is multi-purpose. In the face of a scarcity, this allows users to adapt consumption to maintain highest-priority applications. Conversely, a well-known threat to reliability (e.g. reliability of gas vaccine refrigerators) is that staff priorities may be different from health planners', and supplies may be used for domestic use at the expense of clinic functions.

It is also widely accepted that staff welfare is of high importance. By accepting this, a first step is to provide sufficient fuel for staff domestic use; and this would imply taking the costs and benefits of staff supply into account when considering the reliability of "clinic" supply. Further guarantees depend largely on the responsibility of staff, but also on physical security to reduce danger of misappropriation beyond their control, and possibly some simple locked dedication of one cylinder to the most critical loads.

PV systems can be designed to give dedicated priority to particular loads, while sharing any surplus to other parts of the overall supply system (e.g. clinic lighting sub-system, staff houses, etc.). This is similar in effect to locking an over-sized LPG cylinder to a particular load, replacing this dedicated supply before exhaustion and rotating it to be available for lower-priority use. The technical control over use is less visible in the PV example, whereas physical locking of a gas cylinder might seem to question staff responsibility.

The use of vaccine refrigerators for other purposes — frozen chickens, etc. — is also a well-known hazard, most easily resolved by recognising the domestic refrigeration needs

of staff. An additional (standard) gas refrigerator for staff purposes is likely to be the most effective safeguard, whether the vaccine refrigerator is powered by PV or LPG.

A comparison of costs

To illustrate the cost advantages of LPG, instead of PV supply, for primary clinic energy needs including refrigeration, a kind of "worst case" is analysed — vaccine refrigeration costs are considered in isolation. If LPG comes out favourably for this application, it is probable that the comparison would be even more favourable for (a) a cluster of LPG applications at a clinic, and (b) if externalities from a reliable local fuel transport system are considered.

(However, within this argument there remains space for the advantages of a small dedicated PV supply for essentially electric requirements, primarily for telecommunications, possibly for some specific lighting needs.)

For vaccine refrigeration, the following questions are posed:

- at what cost (e.g. per kilogram of reliably delivered fuel) would LPG break even with PV supply?
- what are likely cost ranges, per kg of reliably delivered LPG?

Appliance costs

Assume a suitable PV fridge costs R4000 to R8000, and a suitable gas fridge costs R2000-R3000. In each case, spare parts are added at 50% of purchase price (up-front); full replacement after 10 years.

Future costs are discounted at 5% real discount rate. Three time-spans are considered, 5 years, 10 years, 20 years.

	Purchase price (RANDS)	Present value (5% real d.r.)		
		5 years	10 years	20 years
PV fridge plus 50% for spares	6000 to 12000	6000 to 12000	6000 to 12000	9700 to 19400
LPG fridge plus 50% for spares	3000 to 4500	3000 to 4500	3000 to 4500	4800 to 7300
Difference (present value)	1500 to 9000	1500 to 9000	1500 to 9000	2500 to 14600
Annualised difference at 0% interest rate		300 to 1800 R/year	150 to 900 R/year	125 to 730 R/year
Annualised difference at 5% real interest rate		350 to 2080 R/year	200 to 1170 R/year	200 - 1170 R/year

Routine maintenance

Assume two visits per year (the same for LPG and PV options), covering full system. Kangwane Public Works quote: approximately R50/hour plus R0.80/km. (NB: mileage rate seems unrealistically low).

Time: 2 hours on site, 1 hour per 50 km. Costs for 2 visits per year:

40 km roundtrip: R350/year
100 km roundtrip: R560/year
(No difference between LPG and PV)

Energy supply costs

These are compared using annualised costing, with 5% discount rate on future expenses and 5% interest rate on amortisation (or "opportunity cost" of capital investment). The energy supply cost for PV includes capital and recurrent costs of the supply system.

(a) PV

[Parameters: weather range - Upington to Nelspruit; module price R24/Wp; batteries R5/Ah at 12V, 70% DOD, lifetime 3 years; system maintenance (non-routine) 15% of capital cost; installation and balance of system 20% of capital cost; no salvage value on system at end-of-period.]

Fridge power consumption: 1 kWh/day (design average)

Levelised unit energy cost, using POWACOST software:

over	5 years:	R9 to R12/kWh
	10 years:	R5.50 to R8/kWh
	20 years:	R4 to R5.50/kWh

NB: these estimates are sensitive to discount rate. For example, the corresponding unit costs on a 10-year timespan at zero discount rate are R4.50 to R6.50/kWh.

Annualised cost of supplying energy for fridge:

over	5 years:	R3285 to R4380 per year
	10 years:	R2010 to R2900 per year
	20 years:	R1460 to R2010 per year

(b) LPG

The costs of reliable LPG supply include:

- the regulated LPG price (presently about R2.12/kg, including a wholesale margin)
- transport of 48 kg cylinders to a local distribution depot (e.g. a department of public works)
- transport from local distribution depot to clinics, including vehicle maintenance to required reliability levels
- the costs of the organisation and staff required for reliable local distribution
- cylinder deposits, depot storage, on-site storage

- the cost (or costing of the risk) attached to unintended use of the LPG

The approach taken here is

i) to quantify typical costs of the elements above which are more predictable;
ii) to conceive of a "premium", added to these elements, which could cover less predictable costs;
iii) estimate the total LPG cost (per kg) at which the gas option would approximately break even with the PV option;
iv) from this comparison, see what "premium" is available for cost-competitive reliable LPG use.

More predictable elements:

Delivered cost of 48 kg cylinders to the local distribution depot. BP (Johannesburg) quotes R112 per cylinder, delivered to Nelspruit, R115 per cylinder to Mmabatho or Pietersburg, on quantities appropriate. [NB: The example of the Kangwane government delivery contract, at R333 per 48 kg cylinder to the Department of Public Works, appears to be clearly out of line. A local entrepreneur's quote for supply and local delivery, R125 per cylinder plus R2 per local km, is more in line.] The unit price, on BP quotes, is R2.33 to R2.40 per kg.

Assuming a typical LPG fridge consumption of 0.5 kg/day and a unit cost (delivered to local depot) of R2.40 /kg, the corresponding cost per clinic is R438 /year.

Distribution from local depot to clinics. Difficult to estimate real costs. Kangwane costs their present delivery to clinics as follows: 300 km round-trip, once a month, delivering 40-50 48 kg cylinders, transport cost R1.35/km, therefore approximately 20c per delivered kg. It seems likely that this transport rate would not reflect true staff, operating and maintenance costs. Local entrepreneur's quote: R2/km travelled.

Obviously the local distribution costs are sensitive to the distances between delivery points, condition of roads, the frequency of delivery, and whether transport is single-purpose or multi-purpose.

Assume R2/km is a reasonable base estimate. For clinic refrigeration alone (excluding other uses) consumption requirements are approximately 0.5 kg LPG per day, giving a replacement period for 48 kg cylinders of about 3 months. (If other end-uses are included, the local distribution cost element would become more favourable, so these are conservative assumptions with respect to LPG costs for refrigeration.) On these assumptions, local distribution costs are:

	Cost element: LPG distribution from local depot to clinics (@ R2/km, 48kg per delivery)			
Mean distance between clinics	R/delivery	R/48kg	R/kg	R/year per clinic
10 km	R20	R20	R0.42	R80
20 km	R40	R40	R0.82	R160
50 km	R100	R100	R2.08	R400

c) Comparing PV and LPG energy supply costs

Note that these comparisons are only for costs of refrigeration. Annual levelised energy supply costs are estimated per clinic. LPG costs include local distribution, as above.

i) Mean distance between clinics: 20 km

Timespan	PV energy cost (R/year/clinic)	LPG energy cost (R/year/clinic)	Difference
5 years (interest rate 5%)	3285 to 4380	600	2685 to 3780
10 years (interest rate 5%)	2010 to 2900	600	1410 to 2300
10 years (interest rate 0%)	1640 to 2370	600	1040 to 1770
20 years (interest rate 5%)	1460 to 2010	600	860 to 1410

ii) Mean distance between clinics 50 km

Timespan	PV energy cost (R/year/clinic)	LPG energy cost (R/year/clinic)	Difference
5 years (interest rate 5%)	3285 to 4380	840	2445 to 3540
10 years (interest rate 5%)	2010 to 2900	840	1170 to 2060
10 years (interest rate 0%)	1640 to 2370	840	800 to 1570
20 years (interest rate 5%)	1460 to 2010	840	620 to 1170

Therefore, even at a mean distance between clinics of 50 km, there is scope for a premium on LPG supply, while remaining cheaper than PV supply. Before quantifying the possible premium further, appliance costs will be added.

i) Mean distance between clinics: 20 km

	Annualised cost difference, per clinic, per year, between PV and LPG (without premium)		Scope for premium
Timespan	Difference in energy supply cost	Difference in appliance cost	Total difference (without premium)
5 years (interest rate 5%)	2685 to 3780	350 to 2080	3035 to 5860
10 years (interest rate 5%)	1410 to 2300	200 to 1170	1610 to 3470
10 years (interest rate 0%)	1040 to 1770	150 to 900	1190 to 2670
20 years (interest rate 5%)	860 to 1410	200 to 1170	1060 to 2580

ii) Mean distance between clinics: 50 km

	Annualised cost difference, per clinic, per year, between PV and LPG (without premium)		Scope for premium
Timespan	Difference in energy supply cost	Difference in appliance cost	Total difference (without premium)
5 years (interest rate 5%)	2445 to 3540	350 to 2080	2795 to 5620
10 years (interest rate 5%)	1170 to 2060	200 to 1170	1370 to 3230
10 years (interest rate 0%)	800 to 1570	150 to 900	950 to 2470
20 years (interest rate 5%)	620 to 1170	200 to 1170	820 to 2340

The break-even premium is at least + 100% of the basic LPG supply cost, calculated earlier from the present quoted cost of 48 kg cylinders delivered to a local depot, plus R2/km for local distribution. (It could be as high as + 700%, on extreme assumptions of a 5-year time horizon, expensive PV fridge and Nelspruit climate.)

It is suggested that a reasonable estimate for the premium per clinic is in the region of R2000 per year (more than + 200% of the basic LPG supply cost.)

This premium is notionally available to cover:

- local delivery vehicle operation and maintenance costs in excess of R2/km
- any additional organisation and staff overheads required for reliable local delivery
- interest on cylinder deposits (note that the regulated price includes an allowance for cylinder maintenance by the supply company)

- storage at depot and on site (note that no bottling is required, and handling is minimal)
- any costs associated with unintended use
- escalation in LPG basic supply prices

To give an example of the scope for covering higher supply costs: the true cost of local reliable delivery could rise from R2/km to R6/km, and this would only absorb half the available premium.

Discussion

The obvious conclusion would be that LPG-powered clinic refrigeration is, very probably, much cheaper than PV-powered fridges except perhaps in exceptional circumstances (no roads?).

This conclusion appears in line with international opinion. Where reliable LPG is an option, WHO recommendations make it the preferred choice. More generally, for conventional refrigeration, LPG is usually recommended as a cheaper option than solar.

Other energy uses

If LPG is used for other energy purposes at a clinic (as commonly the case, even if vaccine refrigeration is PV-powered) the unit transport costs per kg LPG will come down, making the comparison even more favourable to the LPG refrigeration option.

Reliability of LPG supply, which is a costable priority for vaccine refrigeration, can carry tandem benefits for the other energy applications, including staff needs.

If a small PV system is still employed for specific electricity requirements, and the costs of this system and its maintenance will be incurred anyway, a question is whether the marginal costs of a larger system (supplying refrigerators, more lights, etc.) would be low enough to compete with LPG. However, the only substantial shared overhead is maintenance visits, while the main PV cost components are directly related to energy supply capacity (the size of the system) and energy consumption (affecting the recurrent cost of battery replacements). Marginal costs of using PV power for further applications remain high. Appliance costs also tend to be higher for PV applications, both for refrigeration and for lighting (for example, the appliance cost component for operating a 9-watt PV-powered fluorescent lamp can be about 20% of total life-cycle costs).

Time horizons

The economics of PV supply are strongly adverse if the equipment only fulfils its functions for a limited lifetime (e.g. 5 years). It is proposed that time horizons longer than 10 years would be unrealistic in the present context, not so much because of technological failure, but rather because of a changing use environment, future possibilities for grid supply, etc. Some costs of a short project life could be offset by relocating equipment elsewhere, but only to a limited extent.

Versatility to meet changing energy demand

It is difficult in any case to evaluate energy demand with accuracy, and a disadvantage of PV supply is that the energy supply capacity of a given system is fairly constant. If over-sized, the unit energy cost will be higher; if under-sized, needs will not be satisfied. The

LPG option is more versatile in this respect, since fuel supply can be tailored to changes in actual demand, both in the medium- and longer-term.

Externalities

This is of course a very complex question. Broadly, development investments can be considered more favourable if they are synergistic with other development aims (e.g. shared infrastructure, local organisational empowerment, skills development, employment generation). But outcomes can become less certain if they entail complex interdependencies (e.g. reliance on local organisation, skills development, etc.).

A few specific points are suggested:

- Transport is a crucial ingredient in improving human and material services in remoter rural areas. There could be direct (energy provision) benefits in a reliable system of fuel distribution to clinics and similar rural institutions. If such a transport service can be rationalised to include extension-staff transport, maintenance visits, etc., there are further opportunities for synergy.

- In principle, private consumers/producers could benefit from a well-organised multi-purpose transport service. The institutional complexity and feasibility of such a proposal would need to be assessed at a district level. The main energy component revolves around cheaper, more efficient access to transported fuels.

- A dedicated PV (or other RAPS) system at a clinic carries significant externality benefits only if it delivers community benefits additional to the design health service functions. The most likely role here is in providing a telecommunications link.

- The following considerations are not relevant, except perhaps symbolically, to a choice between LPG and solar supply for clinics:

  - environmental considerations (the difference in fossil-fuel use or polluting emissions is less than minute, compared with nationwide and international energy use effects)

  - foreign exchange (both options have a foreign exchange component estimated in the region of 20 - 30%)

Conclusions

1. LPG is the cheaper energy supply option for primary energy needs in off-grid clinics.
2. Reliable LPG supply requires reliable funding (and institutional control) for O&M expenses. So does PV energy supply, in approximately the same magnitude.
3. The comparative cost advantage of LPG supply provides a premium, estimated at typically about + 200% of basic supply-and-distribution cost, available for supporting reliable delivery. (This comparative advantage is based on vaccine refrigeration costs.)
4. Externality benefits probably favour LPG, focusing on the benefits of transport rationalisation.
5. There is no significant difference in the quality of service achievable with LPG or PV supply (provided suitable quality appliances are used), except for essentially electric applications (telecommunications and electronics, possibly some specific lighting applications, and the separate question of PV water pumping, where applicable).