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AN INTEGRATED RURAL ENERGY STRATEGY FOR THE UPPER TUGELA LOCATION, KWAZULU

by

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ABSTRACT

A proposal to develop the Upper Tugela Location in KwaZulu, Natal, prompted this study. This study aims to investigate the means to enhance the availability of, and access to, affordable energy sources in the Upper Tugela Location. A further aim is to match appropriate energy sources with the socio-economic conditions prevailing there. The Upper Tugela Location is an ecologically sensitive area of the Upper Tugela catchment.

Rural energy planning has been criticized for the development of energy-conversion technologies while there is insufficient understanding of energy procurement practices in rural subsistence economies in South Africa. Qualitative information gained from a questionnaire survey, informal group discussions and direct observations suggest that the inhabitants of the Upper Tugela Location are relatively poor. For this reason a basic rural energy needs approach, which attempts to address the needs of the poorest, has been adopted to provide a theoretical base for the study.

Research has revealed the following. Wood is the dominant energy source in the Upper Tugela Location. It is estimated that the annual household consumption of fuelwood is 3000 kg which is below the average fuelwood consumption for a rural area in South Africa. This reflects that this resource is being depleted to the degree that the local inhabitants are supplementing their use of fuelwood with expensive commercial fuels such as coal and paraffin. Locally available wood is in short supply, particularly in densely populated areas of the Upper Tugela Location. Most people are buying fuelwood from Natal farmers living on the borders of the study area. This results in an economic leakage from the Upper Tugela Location and dependence on extralocally available sources of energy. There appear to be few attempts to establish woodlots at present in the Upper Tugela Location. Equitable access to local supplies of wood are curtailed.

Renewable sources of energy such as thermal and photovoltaic solar engery, micro-hydro and wind generated power, and afforestation have been investigated as have non-renewable sources of energy such as grid electricity and commercial fuels.

It is concluded that no single technical option adequately addresses the energy needs of the inhabitants of the Upper Tugela Location. Most of the renewable sources of energy, except wood, are too expensive for subsistence economies and can be unreliable as they are still at the developmental stage.

It is recommended that electricity from the national grid should be made available to those who can afford it. The

means to improving the distribution of commercial fuels in the Upper Tugela Location should be addressed. Woody biomass management and agroforestry programmes provide the best options for an energy strategy for the Upper Tugela Location as they are inexpensive, require little maintenance, are sustainable and reliable, and serve conservation requirements at the same time.

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CHAPTER 1 : INTRODUCTION

1.1. The Rationale for an Integrated Rural Energy Strategy

The KwaZulu Government in Natal, South Africa, is currently engaged in a development initiative in the Upper Tugela Location, KwaZulu (see Map 1). The objectives of this initiative are as follows:

> "To plan and promote a strategy for the co-ordinated socio- economic development of the Upper Tugela catchment area in order to ensure the optimal utilisation of the natural resources of the area on a sustained basis, and to improve the quality of life of all the inhabitants" (Unpublished memorandum of the Upper Tugela Catchment Co-ordinating Committee).

The development initiative is an attempt to integrate all aspects of rural development, such as the provision of services, agricultural development and nature conservation into one major project. This study forms part of that initiative, namely an attempt to present an integrated rural energy strategy for the Upper Tugela Location.

1.2. The Problems Addressed in this Study

It is suggested that the issues related to an integrated rural energy strategy are complex as there is a disjunction between the broader issues of rural development and rural energy planning. Too much emphasis has been placed on the development of energy-conversion technologies at the expense of understanding the socio-economic problems that the energy conversion technologies are supposed to solve (Foley, 1987). The objectives of this study are therefore threefold.

1.3. The Objectives of The Study

The objectives of this study are:

1. to prepare a contextual basis for rural energy planning through the application of rural development planning theory; this is necessary as no integrated rural energy plan has been attempted before in South Africa;

2. to examine existing opportunities in and constraints on efficient energy utilisation in the Upper Tugela Location in terms of the affordability and availability of, and access to, energy sources. These will be studied in the context of the theoretical position developed, will be compared with energy patterns established elsewhere in South Africa, and will be presented as an energy profile for the Upper Tugela Location;

3. to present possible options and recommendations for the implementation of a rural energy strategy for the Upper Tugela Location.

1.4. The Key Questions

The key questions to be addressed in this study are:

1. What is the most appropriate rural energy planning approach for the Upper Tugela Location?

2. What are the energy consumption patterns in the Upper Tugela Location?

3. Which are the recommended technical options for an integrated rural energy strategy for the Upper Tugela Location?

The key questions of this study will be addressed in nine chapters: (1) the first chapter presents the rationale for this study, (2) chapter two will describe the physical and socio-economic features of the Upper Tugela Location which are relevant to an energy strategy, (3) chapter three will present the methods used to collect data, (4) chapter four will investigate the theoretical approaches to rural energy planning and will suggest the most appropriate approach for an energy strategy for the Upper Tugela Location, (5) chapter five will review studies conducted on energy profiles elsewhere in South Africa to provide a basis for comparison with an energy profile of the Upper Tugela Location, (6) chapter six will attempt to present an energy profile of the Upper Tugela Location, (7) chapter seven will review the technical options for improving sources of energy in the Upper Tugela Location, (8) chapter eight will present woody biomass management and agroforestry programmes for the Upper Tugela Location and the final chapter, (9) chapter nine will present a conclusion and recommendations for an integrated rural energy strategy for the Upper Tugela Location.

1.5. A Limitation to This Study

This study is primarily concerned with rural domestic energy utilisation. If the development initiative directed at the Upper Tugela Location is successful, then a subsequent rise in agricultural and economic productivity could be anticipated. The high degree of domestic energy utilisation in relation to other energy utilising tasks could then be expected to drop. Thus, agriculture and commercial activities would increase in prominence requiring a possible restructuring of energy-source supply strategies. That eventuality has not been addessed due to the limited time and scope of this study. This study is not, however, a final statement. Ongoing research will be required to ensure that the energy strategy is flexible and adequate for

a changing community.

CHAPTER 2 : THE STUDY AREA

2.1. The Physical Characteristics

2.1.1. Location of the The Study Area

The Upper Tugela Location (referred to as the UTL) is located in the South African province of Natal in the foothills of the Drakensberg Mountains (see Map 1). It lies between latitudes 28° 37'S and 28° 58'S, and between longitudes 28° 55'E and 29° 25'E. To the west it is bordered by Lesotho, while the small towns of Bergville and Winterton both lie approximately 10 km to the east of the area. The northern and north-eastern boundaries of the UTL are formed by the Tugela River and the Woodstock Dam except for the Rookdale area which lies on the northern bank of the Woodstock Dam.

2.1.2. Climatic Characteristics and Arable Potential

The Upper Tugela Location falls within the summer rainfall region of South Africa and has frequent and severe thunderstorms during that season. Rainfall is relatively high in the mountainous areas, 1500mm annually, decreasing with altitude to 800mm annually. The average is approximately 1075mm per year (Muller et al, 1987). With the variation in altitude there is an associated variation in temperature. Temperatures range from cold to very cold in winter and mild to warm in summer. Droughts are rare. Frost is very severe from May/June to September/October while hail is seasonally severe (Phillips, 1973).

The UTL covers a total land area of 103 306 ha. One third of the study area is arable, although with irrigation this fraction could be increased. Soils are low in nitrogen and are acidic. Extensive fertilization is required to achieve reasonable crop yields and lime is needed to neutralize aluminium toxicity (Muller et al, 1987). These factors need to be taken into account in the implementation of agricultural or agroforestry programmes. Extensive work has been done on soil mapping (Drennan, Maud & Ptns., 1986).

2.1.3. Present Appearance of Vegetation

Ground cover, where land is not under agriculture, mainly consists of open short grass, some short Protea open woodland and isolated relict 'shells' of Podocarpus forest (Phillips, 1973). The alien **Acacia mearnsii, A. dealbata, Eucalyptus spp.**, and **Populus canescens** are common throughout the study area.

2.1.4. Soil Erosion

The area has been reported to be generally free from soil erosion (Drennan, Maud and Ptns., 1986). One reason for this is that few soils of high erosion potential occur in the UTL. Nevertheless, considerable soil erosion is conspicuous on the non-arable, steep slopes. Significant erosion has also taken place in the lowermost, dryer region, south of the Woodstock Dam.

2.1.5. The Forestry Potential

Despite the high rainfall in the area, forestry is not feasible on the steep slopes as these are mainly underlain by Beaufort Shales. The occurrence of hard rock at shallow depths is characteristic. Drennan, Maud and Partners (1986) state that **Acacia mearnsii** is the most suitable variety of wood species for fuelwood purposes. For commercial enterprises, plantations of **Pinus patula**, **Eucalyptus macarthurii** and **E. fortigata** would probably be the most appropriate (Gandar, pers. comm.). It is estimated that in the UTL an area of unused land of approximately 1000 ha is suitable for commercial forestry purposes. The higher slopes, underlain by basalts, may support forestry but it is more likely that these areas will be reserved as wilderness or grazing areas (A'Bear et al, 1987).

2.1.6. The Woodstock Dam

The Upper Tugela Location is part of an important water catchment area. The Woodstock Dam was built as part of the Tugela/Vaal intercatchment water transfer scheme. It cost

R600 million to build and has a capacity of three hundred million cubic meters, which is 58% of the mean annual runoff of 518 million cubic meters. The Woodstock Dam has the potential to be of direct value to the inhabitants of the UTL through the implementation of irrigation schemes and micro-hydro electric programmes. The potential for energy from this dam is reviewed in Chapter 7.2.3.

2.2. The Socio-Economic Characteristics

2.2.1. Land Tenure

The Upper Tugela Location has three different types of land tenure : traditional tribal tenure, South African Development Trust control and private freehold land. The largest area is held under traditional tribal tenure (approximately 95%), while Development Trust control extends over approximately 5% and a half percent is private freehold land (see Map 2).

2.2.2. Topography and Population Density

According to Muller et al (1987), there are an estimated 75 000 people living in the UTL and the population is rapidly growing. As a result of labour migration there is a preponderance of women, old people and children in the UTL, typical of other "homelands" in South Africa. There are also high levels of unemployment and dependence on unreliable migrancy wages.

As the UTL falls within the foothills of the northern Drakensberg mountains, much of the area is mountainous. In these areas there is a low population density. In broad terms, the topography starts changing from very flat, highly productive, white occupied land, which lies just beyond the study area and furtherest away from the mountains in the east, to undulating lands extending up the valleys in narrow bands. The remaining parts are characterised by steep to very steep slopes and mountain plateaux (Muller et al, 1987).

2.2.3. Tribal Groups

Although there are three tribal groups in the UTL, the Amangwane, Amazizi and Shabalala, this study involves only the Amangwane and Amazizi tribes. The Shabalala tribe is a very small group and very locally situated. The Amangwane tribe is by far the largest group, occupying two thirds of the study area. The Amazizi tribe is confined to the north of the UTL (see Map 2).

2.2.4. Accessibility to Urban Areas

The Upper Tugela Location has been divided by A'Bear et al (1987) into three zones of accessibility: high, medium and low; based on its physical characteristics and the degree of proximity to urban areas beyond its borders (see overlay to Map 2). In this division the high accessibility zone indicates close proximity to services and infrastructure, a relatively high degree of local mixed economic activity and interaction with larger economic centres. The medium accessibility zone indicates close proximity to secondary roads with one or two taxi or bus visits a day. The low accessibility zone is characterised by households situated far up major valley systems and on the foothills (Little Berg), with no vehicular access.

2.2.5. Household Income

The characteristics of household income have been mapped by Muller et al (1987) and are as follows. Levels of income are in general lower than the mean household subsistence level for KwaZulu. The annual household income for the UTL ranges from R168,74 to R5 195,14. "Locally generated incomes from farming (16,3%), the informal sector (5,2%) and miscellaneous sources (1,8%) are insignificant indicating a high dependence on the labour market and the external orientation of the community" (Muller et al, 1987:60). The wealthier households receive income from varied sources, ranging from pastoral and crop income, farming income, migrant remittances, local wages, informal sector income, pensions and miscellaneous income, "indicating that it is greater earnings from all sources, rather than better access to a particular source that underpins increasing incomes" (Muller et al, 1987:62).

2.2.6. Summary of Physical and Socio-economic Characteristics

It is apparent that the Upper Tugela Location is neither physically nor demographically homogenous. There is a danger therefore in the unwitting exclusion of some important factor in this study. In an attempt to recognize the pertinent features of the UTL, attention has been paid to the selection of a theoretical approach that will encompass both the physical and socio-economic factors necessary to develop a holistic plan.

The UTL has good arable and forestry potential in general. The potential exists for the production of locally grown, low quality energy sources such as fuelwood, and the establishment of higher quality energy through the use of micro-hydro power from the Woodstock Dam. The UTL is also an important and ecologically sensitive area as it is part of the Tugela river catchment system.

The majority of the rural people who live in the UTL are relatively very poor. The approach that will be taken in this study will address the basic energy needs of the poorest in the UTL in the context of sustainable natural resource utilisation in an ecologically sensitive area. This approach is congruent with the development initiative, as it was stated by A'Bear et al (1987), that the development initiative will adopt a basic needs approach as its planning strategy. Prior to the discussion on the planning approach adopted by this study in Chapter Four, it is first necessary to describe the methods used to collect information.

CHAPTER 3 : METHODS

Data for the study were collected from a literature review, a questionnaire survey, direct observations and from informal group discussions. Each of the foregoing is discussed further below.

3.1. Literature Review

Five interrelated topics were surveyed, namely:

1. The physical and socio-economic characteristics of the Upper Tugela Location.
2. Methods to be employed to gather information for this study.
3. The theoretical concepts related to basic needs approaches and Third World rural energy planning.
4. Rural energy consumption patterns in South Africa.
5. Appropriate rural energy technologies.

Although much has been written in the international literature about rural energy, most studies deal with the introduction of energy-conversion technologies for Third World countries. South Africa is unusual in that it is a country divided into urban First World and rural Third World conditions. Much of the international literature therefore has little relevance to rural energy planning in South Africa. It is for this reason that while much material was read for this research project, only a limited number of references have been quoted.

3.2. Questionnaire Survey

In 1986 the Development Studies Unit of the University of Natal, Durban, was commissioned by the KwaZulu Department of Economic Affairs to undertake a socio-economic questionnaire survey of the Upper Tugela Location (Muller et al, 1987). This survey was to provide a detailed data base for use by planners and decision makers in arriving at viable options for the development and conservation of the Upper Tugela Location.

Eight hundred and nineteen households were surveyed by the Development Studies Unit. Households were classified in terms of accessibility to services and infrastructure. Within the sampling frame, the sampling procedure used was random and non-proportional.

To provide input to this study, a section of the questionnaire survey was designed to address energy consumption patterns in the UTL. Issues that were addressed were: (1) fuels used for cooking by households, (2) the frequency of wood collection, (3) the frequency of fuel purchase by type, (4) the monthly expenditure on lighting fuel by type, and (5) the place of wood purchase.

Unfortunately, there was a high percentage of cases for which responses were not obtained; for example, approximately 81% of households surveyed did not know how often they purchased gas, while approximately 72% of households surveyed did not know how often they purchased coal. This complicated the interpretation of the energy questionnaire survey considerably. Some results were also ambiguous. For example, the question relating to monthly expenditure on lighting fuel excluded expenditure on candles (Muller et al, 1987:71), yet approximately 85% of households surveyed reportedly used candles (p. 122). These were limitations to the use of this data for the construction of an energy profile for the UTL.

It was thus decided that in order to develop an energy profile of the UTL, information gaps had to be identified and addressed through further investigations. A further questionnaire survey was decided against for two reasons.

First, the inhabitants of the UTL believe that both they and the UTL have been 'over-researched'. Their expectations have been raised but not subsequently fulfilled by various agencies working in the area (A'Bear, pers. comm.). Further research, utilising questionnaires, would have exacerbated this situation as the same householders might well have answered energy-related questions for the second time. Community co-operation with field workers undertaking the surveys could not therefore be guaranteed.

Second, as Muller et al (1987:3) point out, the data obtained in the questionnaire survey undertaken in the UTL "are limited in that they represent the situation as a static set of socio-economic conditions rather than as a set of dynamic, and rapidly changing, relationships". The technique of questionnaires is increasingly being criticised, as Barnett (1982:12) states, "In a relatively new area such as rural energy research, one might expect a considerable variation in research method but the use of questionnaires seems to be almost universal and to be at least partly responsible for stifling much creativity. The use of a questionnaire is liable to impose an alien theory on the data and either predetermine the conclusions of the research or obscure from view precisely those novel elements in the situation that are required to convert a random catalogue of events to real understanding".

As a response to the limited usefulness of questionnaires for rural energy research, it was decided, (1) to utilise what data were available from the survey undertaken in 1986 in the UTL (Muller et al, 1987), and to supplement these with qualitative data gained from, (2) direct observations and, (3) informal group discussions. These three sources of information would be used in the compilation of an energy profile of the UTL.

3.3. Direct Observations

Direct observations of rural activities have been given the name Rapid Rural Appraisal by Chambers (1982). This has probably been done in an attempt to give this activity greater credibility as an investigative technique. Direct observations, however, should be an acceptable method of familiarising the researcher with the study area and its occupants, without depending on jargon for credibility. Direct observations rely on the field experience of the researcher applied in brief visits to a rural community. Visits are planned but unstructured. The technique uses visual indicators which can assess physical and socio-economic conditions by driving or walking through the area concerned.

For this study approximately six weeks were spent driving through the UTL, and 8 000 km were travelled. The six weeks, 28 April - 3 May 1987, 8 - 31 June 1987 and 2 - 16 August 1987, were spent on reconnaissance to familiarise the researcher with the study area. Observations that were recorded included woodlots and the number of households with connections to overhead electricity cables or with solar panels on roof tops (See Appendix 1). As many different routes were taken as possible.

Direct observations, however, cannot stand alone as a repeatable technique for gaining insight to a particular community's energy utilisation activities. A further technique was required which was non-invasive and which did not occupy too much of the community's time. Informal group discussions answer these requirements and were thus conducted in the study area.

3.4. Informal Group Discussions

Coupled with, and complementary to direct observations, informal group discussions were conducted at pre-selected sites to establish an energy profile representative of the UTL. Informal group discussions are useful in revealing unanticipated aspects of rural energy utilisation. Importantly, these discussions also reveal the perceived needs and aspirations of the participants and can reflect perceived changes in energy utilisation practices over time. Informal group discussions allow for flexibility and freedom of discussion denied by other techniques.

One problem with informal group discussions is that a hierarchy of authoritative opinion may be established with just a few of the more forceful members of the group responding. The interviewer has to be careful to ensure that, without coercion, all members of the group participate as fully as possible. Another problem is that the results of these discussions are not empirical and are largely anecdotal.

For this study, six areas were selected for informal group discussions. These areas were selected with the assistance of the tribal chief and the development planners for the UTL. They were chosen to be representative of a wide cross section of the socio-economic and environmental variants of the study area. The areas in the Upper Tugela Location selected for informal group discussions (see Map 2) were:

1. Emmaus, a high access Amangwane area close to Emmaus Mission Hospital
2. Dukuza, a high access Amangwane area close to Woodstock Dam
3. Isandlwana, a medium access Amangwane area
4. Zwelitsha, an Amangwane resettlement area
5. Mweni valley, a low access Amangwane area
6. Bonjaneni, a high access Amazizi area

It was decided that women should be the main participants of the group discussions as they deal most directly with domestic energy procurement. It had initially been decided to interview women from the many sewing groups that operate in the UTL as these women could be depended upon for being at a particular place at a specific time for their meetings. This plan was later rejected when it was recognized that women participating in sewing groups would most likely have some form of regular income and would therefore probably be wealthier than the majority of women living in the UTL.

The strategy that was consequently applied was for the researcher and translator to travel through the selected areas of the UTL searching for random groups of women waiting at the roadside for transport. This was done in the last week of the researcher being in the area, 11 - 16 August 1987. The method worked well. The women interviewed were relaxed and eager to speak to the translator and researcher. The number of women in the groups interviewed ranged from six to ten.

A checklist of points to be raised to establish coherence between the different case studies was devised beforehand. Contradictions and information gaps arising from the questionnaire survey described in 3.2. were listed and these were added to the checklist. The key areas in which information was sought were:

1. The aspects of domestic energy usage which were considered to be most burdensome by the participants of the group discussions.

2. Prevailing energy-use patterns, critical constraints, and problems currently being faced by the participants.

3. Changes in energy utilisation patterns within living memory.

4. Ownership, access to land and cost of wood from woodlots.

5. Whether woodlots were managed, by whom and using what techniques.

6. The extent of use of imported commercial fuels and reasons that current levels of consumption were what they were.

7. How fuels were used and why some were used more than others.

One of the problems experienced was that the discussions frequently had to be interrupted precipitously by the arrival of a bus or taxi. The researcher was fortunate, however, in that none of the discussions lasted less than half an hour. The longest discussion lasted two hours while an hour and a half was the average length of discussion. Another problem experienced was the bad, at times impassable, roads that had to be travelled in the UTL.

CHAPTER 4 : APPROACHES TO RURAL ENERGY PLANNING

4.1. The Background to Rural Energy Planning

There are significant problems in rural energy planning in most countries, including South Africa. There have been considerably more failures than successes as the factors relating to both rural energy planning and rural energy utilisation are more complex than they may at first appear (Foley, 1987). A survey of the literature and research experience reveals that energy planning failures may be attributed to two factors:

The first reason is that rural energy planners have not adequately addressed the problems of rural subsistence and poverty, and their relationship with rural energy procurement. Instead, there is an abundance of literature on technical aspects of rural energy sources, such as solar power and biogas. Barnett (1982:1) states: "A considerable imbalance has arisen in the literature on energy in the rural Third World. It appears that knowledge about energy-related technology greatly exceeds knowledge about the problems which the technology is meant to save." Holland et al (1986) state that to many people energy means oil, gas , coal or even nuclear power. To 'greener' people, energy suggests water, wind, solar, biogas and other renewable resources. But to the rural poor of the developing world, these concepts are largely irrelevant. For them, apart from the frugal use of batteries or paraffin, energy means four things: human power, draught animals, biomass and the sun. These statements identify one of the basic problems in rural energy planning, namely, that it has not yet been made sufficiently explicit in the literature that an energy strategy for a rural community in the Third World is equivalent to an energy policy for dealing with poverty.

The issue of poverty is complex, with few authors seeming to agree on how best to tackle it. Heatley (1979) states that eliminating poverty is what development is all about. Harriss (1980) warns that eliminating poverty is not simple; that poverty is a complex interaction between major determinants such as land tenure and class structure. He also warns that intervention development policies created to counteract poverty often benefit the relatively well-off rather than the poor. Seers (1984:7) states that development cannot be confused with economic development, "Economic growth may not merely fail to solve social and political difficulties; certain types of growth can actually cause them". Makhijani (1980:16) believes that "it is not only the poor or illiterate who need education, but also the literate who must understand the point of view of the poor, the reasons for the existence of poverty and the many-sided efforts that result from actions to ameliorate poverty".

The above statements do not minimise the important role of technology in rural energy planning as energy-conversion devices will always be required to harness energy sources. What is required is a balance between the development of rural energy technologies and an understanding of the needs of the rural poor.

The second reason why rural energy planning frequently fails in its objectives is that the people for whom the planning is ultimately being undertaken do not see energy procurement as a discrete problem divorced from the broader issues of subsistence strategies. Energy procurement is not always given high priority in the eyes of rural communities as food and water are of greater immediate importance, "it is often forgotten (by energy planners) that energy is not the only or necessarily the most important issue facing people" (Foley, 1987:223). Frequent mention is made in the literature of the burden rural women have to shoulder to procure energy. Third World rural women are usually responsible for ensuring there is sufficient energy for household tasks (Sen, 1985). Yet these women are generally not the decision-makers in their communities and have no say in the allocation of land for production purposes, such as agriculture or woodlots. As Foley (1987:214) writes, "No (rural energy) planning programme will work unless the local men and women who have to implement it are convinced of its benefits and relevance to them".

A Third World rural energy strategy directed towards a particular rural community, such as the Upper Tugela

Location in KwaZulu, South Africa, should thus be an integration of technological options and the socio-economic needs of that community.

4.2. The Technocratic Approach

In the introduction to this study, it was suggested that there is a disjunction between the broader issues of rural development and rural energy planning. A technocratic approach to rural energy planning means, by definition, the development of energy-conversion technologies which are intended to be adopted by Third World rural communities (Barnett, 1982). Rural energy technologists frequently misinterpret the goals of rural development. As an example, Gottstein (1980:108) states that, "In the field of nuclear energy, as in other fields, the industrially developed countries should make use of their technological lead, and assist the vast, materially much poorer, majority of mankind with the solution of its problems, to satisfy human needs. Large amounts of capital have been invested in the construction of nuclear power stations in the industrial developed countries, ... export markets (for nuclear technologies) must be found. However, the only potential importers are the United States and the developing countries". It would appear that Gottstein (1980) is confusing human needs with the need to find an export market for nuclear technologies. Foley (1987) suggests that there is a form of "intellectual imperialism" amongst First World energy-conversion technologists who attempt to mould Third World rural energy problems to their specialisation. Simply designing improved rural energy-conversion technologies for the Third World will do little to improve the quality of human life (Foley, 1987).

Many rural households cannot afford to make use of the energy derived from technological devices as many of these are prohibitively expensive. Designing improved technologies for poor people does not solve the problem of an absence of cash to invest in costly equipment. In rural domestic energy use, the actual rates of return from energy expenditure are virtually nil. "High capital costs can mire people in permanent debt if the rates of return are marginal" (Holland et al , 1986:60).

For Third World rural energy technologies to be appropriate, they should be developed within the context of rural developmental theory. One such rural developmental theory, the theory of basic needs, lends itself to rural energy planning.

4.3. The Basic Needs Approach

To define basic human needs, a general discussion is required. 'Basic needs' is a polemical term as its meaning is likely to vary (Lisk, 1982). Absolute basic human needs are considered to be: (1) a sufficient quantity and quality of food, (2) adequate access to clean water and, (3) shelter to sustain bodily functions (Sandbrook, 1982). Development theory, however, states that a planning approach to answering basic needs requires more than addressing strategies for basic survival. Development planning, to satisfy human basic needs, involves the formulation and implementation of policies, programmes and projects that are aimed especially at the fulfillment of individual and essential public consumption requirements (Lisk, 1985). "As far as the satisfaction of basic consumption needs is concerned, the planning framework should relate to such key determinants of economic well-being (at the household level) as ownership and control of productive assets and the levels of productive employment among different socio-economic groups - on the demand side, and the levels and distribution of basic needs output - on the supply side" (Lisk, 1985:19).

Increasing levels of productivity is one idea of what a planning approach to basic needs should entail. There are many other approaches. Sandbrook (1982) states that basic needs approaches are not all the same. The approaches range from conservative to radical perspectives. Sandbrook (1982:19) distinguishes between the two extremes, "a conservative programme would propose piecemeal reforms within the existing national and international economic orders, whereas a radical approach would prescribe a mutually reinforcing set of policies entailing structural change at the national and international level." Lisk (1982) does not believe that the concept of basic needs is purely economical, or productivity growth related. He states that the ultimate objective of a basic needs approach is to achieve significant improvements in levels of living of the poor. This achievement is based on economic development and social progress. The two criteria for addressing basic needs, namely economic development and social progress are compatible as both imply the aim to combat poverty.

Lisk (1985) does not point out that while this basic needs approach requires an increase in the level of production, the essence of a poor community is that it is consumption oriented and non-productive, and is dependent on extralocal agencies to satisfy its basic needs (Derman and Poultney 1987). The aim, therefore, of a basic needs approach in development planning should be to assist a consumption oriented community decrease its dependency on extralocal agencies and increase local production. To increase community productivity, the development planners should at all stages include the participation of the community involved and should aim at increasing the self-sufficiency of the community and at satisfying its basic needs without isolating the community from national development (Lisk, 1985).

How does a basic needs approach that is economically and productively growth oriented have relevance to rural energy planning? It is an appropriate approach to rural energy planning in that it addresses the issues of rural poverty, something that rural energy planning has been criticized for not doing in the past (Foley, 1987).

4.4. The Basic Rural Energy Needs Approach

A rural energy strategy aimed at the local production of affordable and appropriate rural energy sources can be developed through the application of three principles derived from the basic needs approach described by Lisk (1985). These three principles direct the basic rural energy needs approach adopted for this study. They are as follows:

1. Rural energy planners should ensure that the energy sources selected for a rural energy strategy are affordable by the poorest of the community. This does not exclude the implementation of more costly sources of energy as part of the rural energy strategy, but cheaper sources of energy should have priority.

2. Increased access to, and the availability of appropriate rural energy sources, with an emphasis on local production is required to encourage self-sufficiency and decrease dependency on extralocal sources of energy.

3. The local production of energy sources from the natural environment should be achieved on a sustainable basis.

To meet these principles in a rural energy strategy, it is necessary to understand, (1) the levels of income within the community involved, (2) the current local customs and costs of energy procurement, and (3) the physical characteristics of the area which can support the production of energy sources on a sustainable basis.

Three energy profiles have been selected from rural areas in South Africa to form a basis with which to compare energy procurement in the Upper Tugela Location. The three energy profiles were selected as they form part of the most comprehensive rural energy studies undertaken in South Africa.

CHAPTER 5 : RURAL ENERGY PROFILES

5.1. A General Rural Energy Profile for South Africa

The following statements describe a general rural energy profile for rural areas in South Africa. An energy profile refers to a summary of the salient features of energy consumption patterns.

In everyday life a consumer utilises 'high quality' energy in the form of electricity, 'medium quality' energy in the form of commercial fuels such as coal and paraffin, and 'low quality' energy from biomass such as wood and dung. Third World rural dwellers rely mostly on low quality energy for their domestic needs. While energy cannot strictly be 'consumed', most rural energy utilisation processes are of low efficiency and there is no surplus for further use. In this sense, low quality energy may be regarded as being consumed.

Low and medium quality energy are particularly utilised by South African rural people. In this study, South African rural dwellers are black people living within a subsistence economy in the Third World rural areas of South Africa, particularly the 'homelands'. Eberhard and Dickson (1987) state that approximately ninety percent of all rural South African households rely on fuelwood for their domestic energy needs. The principal domestic energy-using tasks are:

- heating, cooking and baking food
- heating and boiling water for consumption and for the washing of clothes
- heating an iron
- lighting for the homestead
- space heating, i.e. heat required to warm a room during cold weather
- miscellaneous tasks requiring heat, such as the brewing of beer

Eberhard (1986:28) encapsulates a general rural energy profile of South Africa:

> "Wood is clearly the dominant fuel, although it is noticeable that other fuels are also extensively relied upon - particularly paraffin and also agricultural wastes such as dung, mealie cobs and stalks. The exception is where crop failures and restricted access to land have limited these alternatives. There have been the beginnings of a shift to the use of commercial fossil fuels such as coal and gas".

The following sections will review studies conducted on specific rural energy utilisation patterns elsewhere in South Africa.

5.2. Three South African Rural Energy Profiles

From Eberhard's study (1986) and those done by Gandar (1983), Best (1979), and Eberhard and Dickson (1987), actual fuelwood consumption in rural areas was found to vary widely. Fuelwood consumption varied from 1705 kg to 5440 kg per household per annum for household consumption. This difference in fuelwood utilisation is due largely to varying wood availability as will be shown in the following energy profiles. Other factors influencing fuelwood consumption should also be recognized, for example, the availability of other sources of energy such as coal. If a coal mine is in operation within relatively close proximity to a rural area, it is probable that the utilisation of coal will be higher there than in a rural area situated far from a coal mine.

Three rural energy profiles, listed A to C, are presented, these will provide a basis against which energy consumption patterns in the UTL can be compared. These are as follows.

5.2.1. Energy Profile A

In Gandar's (1983) study of wood utilisation in the Mahlabatini District of KwaZulu, he concluded that wood chopping was close to, or just over the sustainable limit. Severe chopping notwithstanding, the area of woody vegetation cover had actually increased over the last two or three decades.

In the two study areas in the Mahlabatini District, KwaZulu, Gandar estimated annual fuelwood consumption to be 740 kg per capita for the valley lowveld area, and 620 kg per capita for high grasslands. These figures are considerably higher than study areas in which woody vegetation is decreasing. (See Table 1).

In Gandar's study the alternative sources of energy referred to were; dried dung; maize cobs, which were utilised only seasonally and apparently marginally; and paraffin. Only 8% of households used primus stoves, and then irregularly while 94% used paraffin for lighting. Gandar (1983) states that paraffin provides only approximately 2% of the total domestic energy in his study area. From Gandar's observations it would appear that fuelwood is still a sustainable source of energy and transitions to more expensive fuels have not occurred.

5.2.2. Energy Profile B

Best (1979) undertook an examination of the consumption of different fuels in three villages in South Africa. He states that the pattern of energy consumption in each community is an adaptive response to different conditions and to differences in the supply of fuels. This statement is borne out by the following energy profiles of three different rural areas, drawn from his work.

The first study focused on the Malefiloane village in the Lesotho Highlands, which experiences very cold winters. The vegetation is mostly grassland and small bushes. There are no trees. Fuelwood scarcity is a worsening problem. Income is largely derived from unreliable migrancy remittances (71%) and the most destructive social factor in the long term is a stagnation of production and development in the village; "the village is not self-sufficient in basic needs" (Best, 1979:9).

Jozanna's Nek is the second of the three villages studied by Best. It is situated on the south western edge of the Drakensberg mountains. Winters are cold and dry. Fuelwood is derived from bushy trees and Best states that the maximum biomass fuel potential is only slightly higher than Malefiloane (1979:17) and is therefore also a problem. As with Malefiloane, migrancy remittances are the chief source of income while agricultural activity is low. While figures of income levels are not available, it may be assumed that this village is poor.

Mashunka is the third village studied by Best (1979). It is a village on the valley slopes of the Tugela river. Winters are not as severe as those experienced in the first two study areas. Vegetation cover is valley bushveld with dense tree growth and an abundance of fuelwood. "The increased availability of fuelwood at Mashunka is reflected by an increased consumption " (Best, 1979:16). Mashunka is marked by social conflict, very low agricultural activity and poverty.

At Malefiloane and Jozanna's Nek, a much lower availability of fuelwood results in lower annual consumption compared to Mashunka, which has an abundance of fuelwood (See Table 1). Scarcity of wood is partly compensated for by the use of cow dung. Paraffin is used by all households in the three study areas and it is significant to note that although Mashunka households consume more fuelwood, their consumption of paraffin is not significantly lower (24,3 litres per household per year compared with 26,4 litres per household per year for households in Malefiloane). (Best, 1979:24)

Coal and candles are not reported to be used to any significant degree in these areas. From the above observations, imported commercial fuels do not play an important role in energy utilisation even where fuelwood is scarce. This is probably due to their lack of availability. As Gandar's study was completed in 1983, and Best's in 1979, it would be interesting to investigate whether imported commercial fuels were now being utilised to any greater degree. The following energy profile was completed in 1987 and shows much higher levels of imported commercial fuel utilisation.

5.2.3. Energy Profile C

Eberhard and Dickson (1987) undertook a survey of fuelwood and domestic energy consumption in two regions of Bophuthatswana, with an emphasis on the rapid depletion of fuelwood. It was established that due to agriculture, construction, and fuelwood gathering practices, wood was becoming so scarce that many people were being forced to change to fuels such as paraffin, coal and gas. At the same time fuelwood had become a purchasable commodity where once it was a free resource. Results from a questionnaire survey established, however, that wood is still the dominant fuel. Paraffin, candles and agricultural wastes are also a significant source of energy. The majority (91%) of households use paraffin and only a relatively small number of households use coal and gas. Approximately a third of the sample group interviewed used dry cell batteries for low power appliances such as radios and television.

The per capita annual woodfuel consumption for the six areas surveyed was on average 404 kg (Eberhard and Dickson, 1987:75). 89% of households use fuelwood, but in real energy terms fuelwood constributes only 48% of useful energy used in rural areas. The balance is increasingly being met by fossil fuels, particularly paraffin. "For many there is a harsh choice between walking long distances to acquire free fuelwood or spending higher proportions of their meagre incomes on fuel" (Eberhard and Dickson, 1987:16).

Eberhard and Dickson (1987) highlight a number of phenomena which indicated that fuelwood is becoming an increasingly scarce commodity in Bophuthatswana. These are reported in full as they have direct significance to the energy profile of the UTL discussed later in Chapter 6. They are as follows:

"1. The average fuelwood consumption figures recorded for Bophuthatswana are of the same order of magnitude as other areas where fuelwood is extremely scarce and are very much lower than areas where fuelwood is still readily available.

2. The traditional situation of women collecting headloads of wood from adjacent natural woodland is fast becoming supplanted by the need for households to travel some distance, using transport, to collect fuelwood.

3. What was once a "free" natural resource is fast becoming a commodity for sale. Of the households that use fuelwood, a third of all rural households rely exclusively on purchased supplies and a larger percentage sometimes have to purchase wood. Those that cannot afford the increased economic burden resort to inferior fuels such as

dung and crop residues and the incidence of the use of these fuels is extremely high.

4. Finally, there is the phenomenon that fossil fuels are playing a prominent role where fuelwood is scarce. If villages are graded from most rural to least rural, we see that the shift in fuel usage patterns is away from traditional fuelwood gathering and use, toward the use of commercial fossil fuels. There are many so-called rural areas that are, in effect, isolated closer settlements with little access to agricultural land nor is there much opportunity for employment. It is in these areas that fuelwood scarcities are most acutely experienced" (p. 59).

It is possible that rural energy utilisation in South Africa is at a transitionary stage and that rural energy profiles that were constructed five years ago no longer apply as general reflections of rural energy utilisation. Gandar's (1983) and Best's (1979) studies reflect communities on the threshold of exhausting local supplies of firewood with no major reliance on imported commercial fuels. Eberhard and Dickson's (1987) study shows a rural community with a diffent approach to rural energy procurement. Wood is increasingly purchased from wood merchants, agricultural wastes are not relied upon as much as in the past, and imported commercial fuels are assuming more significant roles as energy sources.

CHAPTER 6 : RESULTS OF INVESTIGATIONS INTO ENERGY UTILISATION IN THE UPPER TUGELA LOCATION

6.1. The Cost of Energy Sources

Productivity is decreasing in the UTL, and the community there is becoming increasingly consumption oriented. This trend is borne out by the 1986 survey conducted in the UTL (Muller et al, 1987) which established that locally generated incomes from farming (approximately 16%), the informal sector (5%), and miscellaneous sources (approximately 2%), are insignificant. This indicates a high dependence on the extralocal migrancy labour market and an external orientation of the community. The necessity for capitalising on as many sources of income as possible is a reliable indicator of marginalized economic activity (Muller et al, 1987). At the same time, Derman and Poultney (1987:206) state that in marginal economies it is usual for the poor to deploy labour in lower but certain income generating activities rather than risk labour in higher but more uncertain income generating activities. Muller et al (1987:59) indicate a probable high degree of income 'leakage'. This means that income available to local households is immediately spent beyond the boundaries of the UTL, in the neighbouring Natal towns of Bergville, Winterton and Estcourt. Derman and Poultney (1987:207) state that the rural areas do not provide a self-contained economy. "At present the nature of economic linkages between the local and developed sectors leads to a net outflow of wealth and capital resources from the rural areas. This inhibits local economic performance and renders most rural production marginal."

Informal group discussion conducted in the study area indicate that while wood is the major energy source, in most instances (excluding the very poor), it is bought from 'wood merchants' who own either a tractor and trailer or one tonne truck. These smallscale entrepreneurs hire labour to cut wood bought from local Natal farmers, whose farms lie on the eastern borders of the UTL. The merchants have an order list and deliver a selected amount of wood to a household on a regular basis. This is a very important source of fuelwood to most householders, except the very poor who cannot afford the financial outlay to buy in bulk. The degree of dependence on the wood merchants, as reflected by interviewees, indicates that not only is there insufficient production of fuelwood, but there is also inadequate access to locally grown fuelwood in the UTL.

A major problem expressed with regard to the purchase of wood in bulk in the UTL is that most people find it difficult to pay large amounts of money at one time. The wood merchants do not always deliver on time, so that the supply of wood often runs out before the new order arrives. Local wood collection, notwithstanding the labour required to cut it, is perceived to be preferable to purchasing wood.

Wood collection means the physical cutting, bundling and transporting home of wood from a forest or woodlot. Headloads of wood are obtainable from the KwaZulu Department of Forestry at Olivia at fifty cents a load. This supply of wood, while cheap, is only available from the local forestry department and is therefore not very accessible to people who live far it. Whole trees may be collected and bought for approximately R3 from a small black wattle woodlot situated in the Isandlwana area. Access to this woodlot is not guaranteed.

A tractor and trailer load of one tonne of wood costs approximately R160 to R180 and lasts about four to five months. The cost of wood bought in this way and the time taken to exhaust a supply appears to be generally uniform. Statements were consistent about the cost and duration of fuelwood supplies. The consumption rate, while only an estimate, would suggest that, if the average household size is seven people (Muller et al, 1987:85), then the annual household consumption rate would be approximately 3000 kg or 428 kg per capita fuelwood utilised. This reflects a lower than average consumption rate (see Table 1) which is probably a result of a shortage of locally available fuelwood.

One headload of wood bought locally from one of the few woodlots in the Amazizi ward cost about R1.50 and was reported to last two or three days. It would seem that few people grow their own wood on any formal basis, i.e.

planting and maintaining woodlots.

At least one coal merchant is known to operate in the UTL. He purchases coal from Harrismith and sells it in ten kilogram bags at R8 a bag on order to local residents. Coal which is bought from Bergville or Winterton costs R7 for ten kilograms. Two rand is added to the cost as this amount is usually charged by the taxi or bus drivers for transportation back to the UTL. Ten kilograms will last approximately one week. The consumption rate must vary widely depending on how much wood is burnt in conjunction with coal. Each family has their own strategy of energy substitution dependent on intermittent availability of the various sources.

It was widely reported that imported fuels, such as paraffin, candles, and coal, are bought in the neighbouring Natal towns. This is a clear example of the external orientation of the community. Prices of paraffin vary with the quantity bought. One litre of paraffin costs 70c if bought from Bergville or Winterton and was generally reported to last one or two days. The price for imported fuels differs markedly in the UTL from shop to shop and does not seem to be determined by distance from urban areas. One small shop in a low access area of Isandlwana sells paraffin for 70c a litre while another, near the high access area of Dukuza sells it for 85c a litre. At the same time, factors other than economics often persuade people to buy goods from more expensive shops and at greater distances than local

Coal is used more frequently in winter and in the afternoons. It was correctly stated by the interviewees that coal burns longer and with a greater intensity than wood. Coal is reportedly never used for the first fire in the morning, as this is a generally hastily prepared meal where intense heat is not required for a long period of time. A combination of wood and coal is used for the evening fire. With the change from round housing units to square 'western' housing units, some respondents noted with regret that fewer open fires are being made and most women now cook on coal-burning stoves. Coal stoves are however, perceived by others to be preferable to open fires as more pots can then be used, and baking is possible. It was nevertheless frequently stated that coal stoves are often badly manufactured and are therefore considered to be inefficient. Most groups preferred electricity to other energy sources though it is not perceived as being 'as warming as a coal stove'. It was felt that electricity would boost the womens' income derived from sewing, as they could then purchase swifter sewing machines.

A packet of six candles cost 80c if bought from Bergville or Winterton and up to R1.50 at some local stores in the UTL. Most of the groups interviewed stated that six candles lasted about a week.

Only two people out of the six groups interviewed stated that they used gas. The rest stated that the heavy cylinders are too cumbersome to carry home, that gas is too expensive as it requires expensive appliances, or that gas is too dangerous if small children are playing nearby. This is an interesting perception as many small children have been burnt by falling into open fires, yet the danger of open fires was not mentioned by anyone.

One informal group discussion was conducted with 'Kwash mothers'. These are mothers who bring their malnourished babies to the Emmaus Mission Hospital for treatment, and who therefore may be assumed to be poverty-stricken. It was established that none of the 'Kwash mothers' bought wood from local wood merchants but many went directly to Natal farms on a hired tractor and trailer to cut wood for themselves. This is a cheaper process than ordering wood through the wood merchant. Prices quoted were between R80 to R100 per one tonne trailer load. This amount of wood lasts approximately three to four months. The Natal farmers are paid R20 for a load and the balance of the payment goes to the vehicle owner.

None of the 'Kwash mothers' used coal, even if they would have liked to, as it is regarded as being too expensive. Though prices are the same for all groups interviewed, relative to income coal prices are much higher for the 'Kwash mothers'. The equal consumption rates as indicated by the uniform length of time that energy stocks last, suggest that energy sources are probably used at optimum efficiency by most people in the UTL.

Cow dung is not often used as an energy source as it is regarded as having a higher priority as a fertiliser. This situation was confirmed by all of the groups interviewed. The same applies to agricultural wastes which are also used as fertiliser. This is an interesting shift from the general rural energy profile outlined in Chapter 5.1. by Eberhard, who states that cow dung and agricultural wastes are not utilised for fuel only when there is crop failure or a shortage of land.

It was frequently stated during discussions that there is a shortage of land though what is more likely is that there an inequitable distribution of land tenure in the UTL. Unfortunately there is little information on this issue.

Major problems perceived by the 'Kwash mothers' group are the shortage of income due to the lack of job opportunities and retrenchment of the men working in the mines of the Transvaal, with an accompanying increase in local poverty. The difference in attitude to life in general between this group and the other groups interviewed is striking in the degree of pessimism expressed by this group concerning improvements in their quality of life, a development initiative notwithstanding. No solutions were envisaged. This group expressed a desire for improved access to cheaper wood and coal, while electricity and gas were perceived negatively, on the grounds of their requiring expensive appliances.

6.2. The Availability of Energy Sources

Current energy production in the UTL is very low. While the UTL has a ready supply of natural and sustainable sources of energy in the form of solar, wind and water, social, economic and institutional constraints at present militate against these sources being utilized. Currently, wood is the only source of renewable energy being harnessed in the UTL, and as will be shown in Chapter 7, this source is being depleted at a rate faster than it is being produced.

Of all fuel types, wood is the most frequently purchased (Muller et al, 1987). Just over 75% of households use wood for cooking. Most of this wood is not collected locally. Nearly forty-five percent of the respondents to the questionnaire survey do not collect wood at all. For those who do collect wood, Muller et al (1987) point out that as population pressures increase so does the time devoted to wood collection, and they have estimated that the mean time for a return trip for wood collection is four hours forty two minutes. Respondents in the informal group discussions who did collect wood, stated that there is an increasing difficulty in obtaining it. It was also consistently stated in the informal group discussions that wood used to be freely available, but that this had changed over the last ten years. Local energy production partly reflects the amount of energy available to the community. Whether all people have access to it is another matter.

An abundance of energy sources may be available in the UTL but, without equitable access to these, for some they may as well not exist. It is imperative that access is equitable if the energy source is not only to benefit the select few.

Accessibility to locally grown wood is limited in the UTL. It was reported in the informal group discussion conducted at the Emmaus Mission Hospital that while two **Acacia mearnsii** woodlots do exist nearby, the access to these is strictly selective. The owner of a woodlot is usually male and is regarded as a person with some influence. He is reported to sell his wood only to people who are either relations or friends of his. The issue of selected inequitable accessibility to woodlots in the Emmaus area is reportedly leading to social tension. The problem of accessibility is also a gender issue as it is the women who have to develop strategies to ensure a regular and reliable supply of firewood while the men control the access to woodlots. The women in the UTL apparently do not have the authority to establish woodlots themselves and speak of not being allowed to plant woodlots. It is unfortunate that it was not possible to establish more specifically on what grounds women are constrained from growing wood as, when questioned, they simply stated there was not enough land available because cattle and crop production had greater priority so that the tribal elders 'did not allow them to grow wood'.

According to the Emmaus group of women, **Acacia mearnsii** used to be available from the South African Department of Forestry plantations in the district, but access to this resource no longer exists owing to an alien vegetation eradication programme.

The predominant source of fuelwood for most householders in the UTL, according to the Emmaus group interviewed, is now the wood merchants already described. For the very poor, access to fuelwood appears to be more haphazard, requiring opportunistic twig gathering.

Access to coal is also regarded as a problem. It is not easily obtainable locally and transporting bags of it from Bergville or Winterton is cumbersome and costly. The amount of coal used is highly variable according to household demography and lifestyle.

In discussion with the UTL shopkeepers, it would appear that one of the major constraints on efficient distribution of imported fuels is simply the lack of organisational infrastructures required to facilitate the delivery of imported fuels into the UTL. Distribution agencies operate on behalf of the large petro-chemical companies to coordinate and distribute products such as paraffin and gas in areas remote from the major industrial centres of South Africa. The feasibility of such an agency operating in the UTL is discussed in Chapter 7.

The second constraint on efficient distribution of imported fuels in the UTL is the condition of the roads in many areas. These are virtually impassable in wet weather. Some shopkeepers maintain that often they have to go without stock for some time if the roads are bad. This problem would hamper the regular delivery of imported energy fuels into the UTL as tankers or trucks would not have access.

6.3. Summary of Results

In summary, the UTL energy profile indicates that conditions at present in the UTL do not meet even the basic needs of energy consumption for the following reasons.

1. UTL families have been split by migrant labour. What income is derived from elsewhere is also spent elsewhere so that the means for local energy productivity is critically curtailed. Thus it is not only social factors, but major economic constraints derived from the political structures which prevent adequate energy sources reaching the residents of the UTL.

2. People have to travel beyond the boundaries of the Upper Tugela Location to purchase expensive

energy sources such as wood that might cost less if it were locally abundant. While people are likely to continue to aspire to imported fuels and their appliances, these would be cheaper if they were locally distributed. To overcome the spatial constraints related to the non-availability of energy sources, distribution links of imported fuels and modes of local energy production should be improved.

3. Access to local sources of energy is inequitable and limited to a select few. To overcome this problem, the institutional constraints inherent in inequitable access require democratic reorganisation. This will be discussed in more detail in Chapter 8.

The energy profile for the UTL bears a close resemblance with Energy Profile C in section 5.2.3. Map 4 shows the energy flows through the Upper Tugela Location. Wood is still the dominant energy source, but is increasingly becoming a purchasable commodity. People are now travelling further to obtain fuelwood. There appears to be a transition to imported commercial fuels, particularly paraffin and coal. More people in the UTL nevertheless, seem to rely on coal than is the case in Energy Profile C. This is probably due to the relatively close proximity of the Natal coalfields to the UTL. Fewer people in the UTL rely on cow dung and agricultural wastes than in Energy

Profile C.

It is suggested that, as Energy Profiles A and B do not reflect the general trends described in Energy Profile C and the UTL profile but were compiled at earlier dates, the transition to purchased wood and imported commercial fuels is a recent phenomenon.

A reorientation of the economics of energy production is required to meet the basic rural energy needs of the UTL. This means that the economic 'leakage' of income from the UTL must be curtailed and that less should be spent on energy sources. This can only occur through the local production of more abundant energy sources in the UTL.

It is not only a reorientation of the economics of energy production that is required but a reorganisation of that production. A reorientation of energy production in the UTL would require a change in the current strategy of energy procurement i.e. from relying on extralocal sources such as Natal farmers and Natal shops, to establishing reliable and sustainable energy sources within the UTL. For the benefits derived from this reorientation to be felt by as many people as possible, this would require the spatial reorganisation of production. It may not be possible to produce fuelwood close to highly populated areas of the UTL such as Dukuza, Emmaus or Bonjaneni due to a shortage of land, but the infrastructure could be established whereby fuelwood grown in medium access and low access areas could be sold in these places, at various distribution points, or by hawkers. It is here that a theoretical principle of rural energy planning is relevant. This is the principle of sustainable self-reliance, in which local resources should be utilized in preference to imports of energy wherever possible. The main criteria for the reorientation and reorganisation of energy production is that production is spatially distributed within the UTL in such a way that energy sources are available to all the inhabitants.

From the above observations, it is possible to suggest recommendations which would assist planners in an integrated rural energy strategy. It is, however, necessary to first assess possible technical options to rural energy planning in the UTL. These are reviewed in the following chapter.

CHAPTER 7 : TECHNICAL OPTIONS FOR A RURAL ENERGY STRATEGY FOR THE STUDY AREA

This chapter will review some of the many technical options for improving sources of domestic energy in the Upper Tugela Location. Only those which have real potential for implementation will be considered.

The technical options presented have been arranged so that external sources of energy to the Upper Tugela Location will be considered first. Local renewable sources of energy will then be reviewed. The technical options to be considered are: (1) electricity from the national grid, (2) imported commercial fuel substitutes, (3) improved distribution links of imported commercial fuel substitutes, (4) fuel efficient stoves, (5) thermal and photovoltaic power, (6) wind generated power, (7) micro-hydro power, (8) energy efficient buildings, (9) commercial plantation waste, and (10) woody biomass management.

7.1. Non-Renewable Resources

7.1.1. Electricity from the National Grid

The controlling body for the supply of electricity in South Africa is the Electricity Supply Commission (ESKOM). It has authority to supply electricity to KwaZulu areas. ESKOM's official approach to the supply of electricity to KwaZulu is that it "is committed" to this but believes that the costs of electrification probably puts electricity beyond the means of most rural people (Kay, pers. comm.). Eberhard (pers. comm.) disputes that electricity is too expensive for rural people. Under certain conditions, for example, for densely populated rural areas, once the initial costs have been paid, electricity is one of the cheaper and more dependable sources of energy. Only two areas in the UTL have been supplied with electricity, the applicants being relatively wealthy businessmen.

7.1.1.1. Economic Considerations

A preliminary cost comparison between electricity, liquid petroleum gas (L.P. gas) and solar energy as applied to KwaZulu rural homesteads was undertaken by ESKOM (Kay, 1988). This study concluded that for certain types of rural dwellings to which Tariff D1 was applied, electricity is considerably more expensive than gas or solar energy "and certainly far more expensive than the rural peoples' present energy practices" (Kay, 1988:1). (Tarrif D1 is the electrical supply rate charged in rural areas in South Africa and is more expensive than the urban tariffs charged for electrical supply. The extra cost factor is due to greater spread between rural homesteads and the point of electrical supply.) To reach this conclusion, three basic assumptions were applied:

1. An average annual income of R4800 was assumed for the three different types of dwellings selected for this study. (This is considerably more than the mean annual household income for the UTL which is R2000, (Muller et al, 1987:60)).

2. The dwelling types considered were "firstly, a wattle and daub hut, secondly, a 'more sophisticated' dwelling, and thirdly, a 'western styled' house" (Kay, 1988:1).

3. Tariff D1 was applied as the rate charged for electrical supply.

The results of this preliminary study show that electricity is very expensive for rural subsistence consumers (See Table 2). While ESKOM officials believe it is necessary to examine the feasibility of alternative sources of energy, such as imported commercial fuels, ESKOM is not likely to become involved in such sources, "What we sanction today, will become our competitors in the future" (Kay, pers. comm.).

The study did not mention what grid extension lengths were used to determine costs of installation. Grid extension lengths would affect the costs of electrical installation, densely settled areas would be cheaper than more remote low access areas.

ESKOM has been faced with many problems in making electricity available to applicants in rural areas. A major problem is a lack of communication links between ESKOM and the applicants. The rural applicant often has no phone nor a personal address. Storekeepers often act as postal depots and communications between the applicant and ESKOM are unreliable. Many problems could be overcome with the deregulation of ESKOM's present urban oriented policies, for example, ESKOM could develop an electricity programme designed for rural areas that is more congruent with rural needs. Subsidisation of an extension of the national grid to the UTL would result in cheaper electricity for this area. It is unlikely, however, that ESKOM will drop its prices or subsidise electricity for rural areas in the forseeable future (Kay, pers. comm.).

In terms of the basic rural energy needs approach adopted by this project, electrification from the national grid would not alone answer the basic energy needs of the poorest for the following reasons:

1. If electricity were too expensive for most people living in the Upper Tugela Location, the present extralocal economic orientation of the community (discussed in Chapter 6), would not be ameliorated.

2. While electricity could increase local entrepreneurial potential, it is likely that only the relatively wealthy would benefit at the expense of the poor who do not have the means to invest in electricity.

3. Electricity from the national grid would not assure equitable access to domestic energy sources. For the same reasons as given above, it would be too expensive for the poor. Poor people can, however, have access to some of the benefits of electricity without having to buy it through schools, community centres, and clinics.

7.1.2. Imported Commercial Fuel Substitutes

7.1.2.1. Coal

After fuelwood and paraffin, more money in the UTL is spent on coal than any other energy source (Muller et al, 1987). As reflected in the informal group discussions, people who do not use coal in the UTL do so because they cannot afford it. The factors of accessibility and affordability militate against greater use of coal in the UTL. It is ironical that there are coalmines in relatively close proximity to the UTL and yet it was stated in group discussions that there is not sufficient access to coal and that it is too expensive. Eberhard (pers. comm.) states that "one of the greatest untapped energy resources in South Africa is coal fines and discards; there are huge dumps of these in the Natal coal fields". While greater access to cheaper coal would partly answer the basic needs of the poorest, it is doubtful whether this would result in a complete cessation of pressure on fuelwood. Improved coal distribution links combined with a successful woody biomass management programme would provide a partial answer.

7.1.2.2. Paraffin

Though paraffin is currently used by all households in the UTL as reported in informal group discussions, it appears that should an acceptable alternative be feasible in the future, most people in the UTL would be happy to abandon the use of paraffin as it is regarded as being smelly and messy. The same problem of accessibility applies to paraffin as to coal. Improved distribution links of paraffin supply within the UTL itself must be addressed to answer the basic energy needs of the poorest.

7.1.2.3. Other Imported Fuels

It is clear from the informal group discussions that took place in the UTL that more affluent people either used or aspired to liquified petroleum gas (LPG). LPG is, however, at present difficult and cumbersome to obtain in the UTL. Representations could be made to large chemical companies, such as Shell South Africa, to investigate the feasibility of improving distribution links to high access areas. Though one of the cheaper sources of energy, (see Table 2), LPG is beyond the means of the poorest people in the UTL, and alternative energy sources would have to be made available to replace the current dependency on fuelwood purchase.

From direct observations, at least eight homesteads were seen to have television aerials. On enquiry, it was discovered that the televisions were powered by car batteries. Unfortunately it is unknown how many people use car batteries as a source of energy though this figure is probably not high.

7.1.3. Improved Distribution Links for Imported Commercial Fuels

While wood is likely to remain the dominant source of domestic energy in the rural areas of South Africa, there is also increasing utilisation of imported commercial fuels. The UTL already reflects a high degree of dependency on commercial fuels such as paraffin and coal.

In consultation with Shell South Africa, it was found that the closest distribution agency for paraffin, L.P. gas and diesel is in Ladysmith, approximately 100 km away. If the demand for paraffin, for example, were great enough, i.e. if the distribution agent in Ladysmith could be assured of a dependable market of 20 000 litres per annum in the UTL, it would be economic to deliver bulk supplies of paraffin to general dealers in the UTL. This is the opinion of the marketing division of Shell South Africa.

It would not be a simple matter to establish a fuel depot in the UTL itself. There is a rationalisation programme within the oil companies which limits their supply of commercial fuels to new depots. It is felt that the relatively low population of the UTL does not warrant the high cost of establishing a depot there.

Two recommendations regarding improvement of the distribution of commercial fuels in the UTL can be made. These are:

1. Determination of the real demand for commercial fuels in the UTL.
2. If there is sufficient demand, negotiate with the distribution agency in Ladysmith to supply imported fuels to general dealers in the UTL.

There is a major obstacle, however, to improving distribution of imported commercial fuels in the UTL. This is the very bad condition of the roads, many of which are impassable in wet weather. Local shop-keepers and general dealers stated that they very often run out of stock because they could not obtain deliveries to their shops. Large fuel tankers simply would not be able to make regular deliveries. As an energy source, commercial fuels would remain undependable and it is therefore likely that people would carry on with their current practice of buying their fuels outside the UTL. This would defeat the aims of the energy strategy.

It is necessary that prior to negotiations with oil companies to establish distribution links in the UTL, major roads must be upgraded. The results of this would not only be to enhance the local procurement of fuel, but would benefit other sectors of the development initiative as a whole.

7.1.4. Fuel Efficient Stoves

Eberhard and Dickson (1987) state that the more efficient the cooking and water heating process is, the less woodfuel is required to improve the quality of human life. "A fifty percent increase in the fuelwood reserves is immediately available for the cost of an effectively implemented stove dissemination programme" (Eberhard and Dickson 1987:80). The women in the UTL stated during informal group discussions that it is well known that coal stoves are indifferently constructed with resultant varying degrees of efficiency. A well shielded fire may often use less fuel than a badly constructed stove (ibid). The solution to this problem lies with the energy conversion technologists and stove construction companies. In time, it is hoped that more energy efficient wood and coal stoves will be on the market at an affordable price for the rural poor of South Africa.

7.1.4.1. Heat Retention Cookers

Heat retention cookers (wonderboxes) are becoming increasingly popular in some South African rural areas. Food can be brought to the boil in the early morning, placed in a wonderbox and, by the end of the day, will be cooked. Alternatively food will remain hot for long periods without further energy input. A lot of interest in wonderboxes was expressed amongst the women in the group discussions. The insulated boxes are relatively inexpensive and simple to construct. Low cost wonderboxes could be manufactured in community workshops and disseminated locally in the UTL. Wonderboxes are an asset to rural women who have to be out of the house all day on other chores. While wood and possibly coal will be necessary for the first fire of the day, the amount used would be reduced.

7.1.4.2. Constraints

The dissemination of wonderboxes in an area where poor people are unaware of them is problematic. This would be the case in the UTL where respondents in informal discussions indicated that they were ignorant of wonderboxes.

7.2. Renewable Sources of Energy

7.2.1. Wind Generated Power

Diab (1986) has identified the UTL as having a good wind energy resource base. The type of energy potential from this source would be high quality energy, i.e. electricity. The annual kilowatt hour production from wind turbines is dependent on machine type and wind speed. These figures are obtainable from the wind turbine manufacturers, of which there are many. The higher the wind speed, the lower the cost per kilowatt hour and the more competitive wind energy becomes. Expert opinion is agreed that the most appropriate application for wind power is on a decentralized basis in underdeveloped areas or in areas remote from the ESKOM national electrical grid (Dutkiewicz, 1986). Stand alone systems are favoured over connection to the national grid as they promote greater independence for the rural user.

7.2.1.1. Constraints

The more remote areas of the UTL would benefit most from wind generated electricity. Those areas in the UTL physically best suited to wind energy are in the low access regions where the wind is channelled by river valleys. Electricity generated from a wind/hydro hybrid system in the river valleys is theoretically feasible. The present cost of wind-generated power, while perhaps meeting the high quality energy requirements for the more affluent inhabitants of the UTL, precludes it from addressing the basic energy needs of the poorest people who cannot afford the relatively high capital cost of wind turbines and generators.

Other limiting factors to wind energy implementation are, (1) the lack of performance information of wind turbines under South African conditions. The shortage of technical back-up and experience by importers and distributors of wind turbines in South Africa also means that users of wind turbines in the UTL would require alternative high quality energy generators should their systems fail or require replacements, (2) wind speeds are unpredictable. The energy produced from this source must therefore be used when the wind provides sufficient energy, or expensive energy storage units must be installed.

7.2.2. Thermal and Photovoltaic Solar Power

7.2.2.1. Solar cookers

Solar cookers initially appear to offer an attractive alternative to woodfuel for preparing meals. Insolation levels are high in the UTL and this energy resource is limitless, clean and free. It would be a feasible project to institute communal workshops in the high access areas to manufacture solar cookers at an affordable cost, thus also creating much needed job opportunities.

7.2.2.2. Constraints

The barriers to this alternative energy source are, in particular, the restriction of having to cook between 10h00 and 15h00 when meals are least required, the need for manipulating the device to track the sun, the loss of the social and space heating aspects of a fire or conventional coal stove and the effective dissemination of solar cookers (Eberhard and Dickson, 1987). In each of the group discussions conducted in the UTL, where respondents knew of solar cookers, objections were raised on the grounds that the solar cookers did not operate in bad weather and that a contingency energy source would be expensive.

Social acceptability of intervention strategies for rural energy supply is important for them to be successful. It must be demonstratable to the rural community that these strategies are more favourable than existing energy supply practices. To date this has been difficult to prove with solar cookers. Solar cookers have the potential to reduce the overall fuelwood requirement but require a concerted dissemination effort and responsible and reliable technical backup. At the same time, it is doubtful whether the very poorest could afford the initial capital cost of a solar cooker. The greatest utility for solar cookers would be for creches and other community daytime operations. Until solar cookers have established a proven track record elsewhere, a strategy for their general implementation in the UTL does not have much feasibility.

7.2.2.3. Individual Photovoltaic Units

Independent, stand alone photovoltaic installations (PV's) are becoming increasingly attractive for meeting minimal electricity requirements such as lighting, radios, televisions, fans and refrigeration. As with wind energy, PV's are clean and the energy resource is free and unlimited. PV's promote user independence, do not require metering or distribution costs, and their modular nature allows for expansion and matching to needs and income (Eberhard & Dickson, 1987).

One major disadvantage with PV's is that they do not meet the needs of the poorest. Holmes (pers. comm.) states that to install a 6 watt PV module, which would be capable of producing approximately two hours of light a day from a fluorescent light, would cost the consumer between R500 and R600, with approximately R120 charged for every additional module. Eberhard disagrees with the costs quoted by Holmes and states that the current cost for energy from a photovoltaic module is R17 per watt. Nevertheless, it is unlikely that poor people in the UTL have sufficient capital to invest in PV's. "Although the cost of PV panels has been dropping in the USA and Japan through the development of thin film technology and growing demand, the exchange rates between South Africa and these countries has meant that the cost per peak watt has remained at about R18 over the last few years. Nevertheless, when compared to the cost of operating a small petrol generator, similar to those being used increasingly in peri-urban areas, PV's become economically competitive" (Eberhard & Dickson, 1987:73).

Most PV modules are manufactured with aluminium frames and glass fronts. They are very fragile and are prone to corrosion if damaged. A new "unbreakable" amorphous silicon module with stainless steel substrate has, however, been designed which should be less fragile (Holmes, pers. comm.). Manufacturers change their model types approximately every two years so that there is a danger of mismatching new panels with installed panels.

Forty PV modules have been installed by an agent from

Ladysmith in the UTL over the past five years. Not one of these systems is functioning now. The failure of these PV modules in the UTL was due to the "total unreliability of backup when the systems failed" (Holmes, pers. comm.). It is felt that PV installations will not address the energy needs of the poorest nor will they reduce the pressure on fuelwood resources as their high cost precludes their use for cooking and heating. Their greatest utility lies with small businesses, community centres and health clinics. As with wind or hydro power generation, PV's have the potential for hybrid device integration.

7.2.3. Micro-Hydro Power

Hydro-electric power generation is renewable, nonpolluting and reduces the rural energy users' dependence on imported sources of energy. The history of small-scale hydro-electric development can provide sound suggestions for helping rural areas of both developed and developing countries achieve an improved standard of life. Small hydropower plants can be both environmentally and aesthetically acceptable. Effects upon river ecology are minor compared to those caused by large hydropower facilities (Olivier, 1986). Dutkiewicz (1984:17) states that the vocabulary regarding small hydro plant installations have been internationally standardised. A micro-hydro plant produces less than 500 kW, a mini-hydro plant is capable of up to 2 MW while a small-hydro plant produces less than 10 MW. This study deals only with micro-hydro units.

Smith (pers. comm.) has identified the Woodstock Dam and the Tugela River upstream of the dam as having the potential to support micro-hydro units. Sufficient water is available throughout the year. This would be a new technology for many of the people living in the UTL as nobody in the group discussions had heard of water as being a source of energy.

7.2.3.1. Components of Micro-Hydro Power Units

The major components of a micro-hydro electric system normally include a dam to create the elevation difference (head), a penstock to convey water to the turbines, the turbine and its discharge piping, the electrical generator and connection between the turbine and the generator. Some small-scale systems have a drop in elevation from the water source to the turbine sufficiently great so that a canal system can be utilized. A dam is nevertheless more effective in controlling stream flow and providing water supply systems (Olivier, 1986). A typical hydro-power installation comprises several additional components such as closing devices, turbine regulators and generator controls.

A potential source of micro-hydro power are dams, rivers and irrigation canal systems. Discharges from these sources often occur under considerable head and dissipating devices are used to reduce the damaging effects of the high energy releases. Large quantities of energy are consequently wasted. There have been recent technological advances, however, which have improved the mechanical and electrical potential to harness this energy as well as reducing the unit cost of components and installation. The requirements for operational micro-hydro units such as dam head heights and water volume vary with the design of the particular units.

A versatile hydro-electric power unit has been designed by the Turbomachinery Research Group, University of Natal. This is capable of meeting both domestic and agricultural energy requirements (Smith, pers. comm.). This inexpensive single phase 8 KVA output system consists of an axial flow turbine which is directly coupled to a generator. The component cost is approximately R3000. This excludes installation costs which are minimal (Smith, pers. comm.).

Most importantly, a low cost electric governor has been developed which is capable of maintaining generator output to within 3% of 50Hz and 220 volts, despite fluctuations in the load applied or withdrawn. The governor is responsible for 'clean' output waveforms. The conventional dumping of excess energy to a dummy load has been adapted to that of a priority based sequential dumping system, with a simultaneously reduced water flow through the turbine in a slow and progressive fashion, so as to reduce water wastage. This is done in conjunction with a progressive reduction in the energy diverted to the dummy load.

This particular design permits up to five ancillary devices such as refrigeration units, small irrigation systems and grinders to act as dummy loads; i.e. when domestic energy requirements drop, energy may then be fed to alternative devices in a sequence which is decided on by the user.

7.2.3.2. Constraints

Olivier (1986) points out that the major expenditure for small hydropower development is the initial capital investment including costs for the main stuctures and generating machinery. Operational and maintenance costs for micro-hydro power facilities have proven to be very low and, once completed, the plant's costs are largely unaffected by inflation. In addition, the actual lifespan normally exceeds its projected economic life, with no significant change in efficiency. At present, however, this source of energy is too costly for rural people with an annual household income of R2000 (Muller et al, 1987). Micro-hydro power may become more appropriate in the future with the anticipated socio-economic benefits accruing from the development initiatve in the UTL.

Another major problem with micro-hydro power is the threat of floods. There seems to be little literature on safe-guarding the micro-hydro unit and its components from being washed away.

As with wind energy, hydro power does not answer the needs of the poorest who could not afford a micro-hydro unit. It is possible that a syndicate of households could co-operate and invest in such a unit. It is unlikely that this would happen for domestic energy purposes however. Micro-hydro power does have an application for cooperation between farmers who may wish to utilise the energy load dumping facility of a micro-hydro power unit for irrigation purposes, grinding, and milling. Local entrepreneurs may also be attracted to micro-hydro power to generate electricity for butcheries and other small businesses.

7.2.4. Energy Efficient Buildings

The energy efficiency of existing houses and schools can be improved in the UTL through insulation and the provision of ceilings and other measures. "The major contribution to a reduction of domestic energy requirements for space heating, and thus indirectly a reduction in demand for fuelwood, is for any new housing developments to be well designed in the first place" (Eberhard and Dickson, 1987:86). It is possible to use low cost wattle and daub ceilings, or even cardboard as ceilings for domestic builings. The KwaZulu authorities could assist in ensuring that schools and other community services in the UTL are adequately insulated.

7.2.5. Commercial Plantation Waste

The South African commercial timber industry produces appreciable quantities of residues which consist mainly of stumps, roots, branches and bark. Timber shortages are predicted, however, in the industrial sector and it is therefore unlikely that existing commercial plantations will contribute in any significant degree to an energy supply in the UTL (Williams, pers. comm.). Should commercial forests be established in the low access areas of the UTL it is possible that these would provide a source of plantation waste and thus energy as long as these were not sold more profitably beyond the boundaries of the UTL.

As wood is still the dominant source of energy in the Upper Tugela Location, priority should be given to afforestation programmes for the area.

7.3. Summary of Technical Options

None of the forementioned technologies alone addresses the principles of the basic rural energy needs approach discussed in Section 4.4. Locally available renewable sources of energy such as solar energy, micro-hydro and wind power, while sustainable and clean, are as yet too expensive for the average household in the Upper Tugela Location. Problems associated with the dissemination of these technologies could be anticipated as they are relatively unknown sources of energy in the study area.

Imported sources of non-renewable energy such as electricity from the national grid and improved distribution of commercial fuels would appear to have social acceptability in the Upper Tugela Location. Expert opinion is divided as to whether the costs of supply of electricity from the national grid to the Upper Tugela Location could be borne by householders there. As already stated, the basic rural energy needs approach adopted by this study does not preclude the options of medium and high qualtiy energy in the strategy. The means to enhancing access to affordable low qualtity energy should be given priority. Some authors such as Foley, (1987) and Baidya (1985) have suggested that programmes for the implementation of formal woodlots in Third World rural areas have largely failed owing to socio-cultural factors. Formal woodlots are not the only means to afforestation. There are other ways to increase the woody biomass of an area, for example, informal woody biomass management and agroforestry.

7.4. Woody Biomass Management in the Upper Tugela Location

7.4.1. Characteristics of Wood as a Fuel

Fuelwood characteristics have relevance in the planning of a rural energy strategy as they will assist in guiding the planner to which tree species would be most appropriate in a woody biomass management programme.

The amount of energy or heat that can be obtained from wood depends largely on the quantities of carbon, hydrogen, oxygen, sulphur and nitrogen contained in the wood. Calorific values for soft and hard woods overlap varying between 18 and 21MJ per kg. "Wood, therefore, is relatively constant in the total amount of heat it will give per unit dry weight" (Burley & Plumtre, 1985:215).

The effectiveness of wood as a fuel also depends upon its density and water content, which controls its rate of burning and volume of smoke emission. Wood should optimally be dried before burning. **Acacia mearnsii** (black wattle), which is a relatively dense wood, will burn slowly and require little drying as the proportion of wood substance is greater in relation to the whole volume. The ratio of surface area to volume varies according to the size of a piece of wood. The higher the ratio, the faster it burns. A small piece of high density wood will burn at the same rate as a larger piece of low density wood. This is significant if the fuelwood is a scarce commodity, or human labour is required to transport it (Burley and Plumtre, 1985).

The factors determining which tree species are an efficient fuel source are as follows. The tree species should:

1. have medium to high density wood
2. have a low moisture content
3. be fast growing
4. be resprouting
5. have small diameter boles less than 10cm
6. have as straight a grain as possible
7. have no odour or allergenic constituents while burning
8. burn steadily without smoke or sparks
9. be able to grow in leached, nutrient-poor or disturbed soils

7.4.2. Evidence of Fuelwood Depletion

It is suggested that the annual household consumption of fuelwood in the UTL is approximately 3000kg which is lower than the average household fuelwood consumption in other South African rural areas. From an outsider's point of view, a fuelwood shortage does not seem obvious in medium access areas in the UTL, where there are many informal **Acacia mearnsii** stands situated close to homesteads. In the high and low access areas, however, these stands are infrequent and situated further from dwellings. Many homesteads have fruit trees planted in the immediate vicinity. While the amount of available wood is therefore not easy to establish, people's access to it in the UTL is more clearly defined. As already indicated, only the most affluent who control some land have private woodlots. Access to these is highly selective, and the wood is considered expensive. All the interview respondents reported this.

While it has not been possible to measure the degree or rate of depletion of wood supply in the UTL, it is possible to record the perceptions of the locals with regard to the status of wood in the UTL. These perceptions are as follows:

1. Everyone in the UTL uses wood as an energy source to some degree.

2. Without exception every person interviewed was of the opinion that wood is becoming scarcer in the Upper Tugela Location.

3. The poorest are particularly aware of the decline in wood supply as they cannot afford to buy wood from

the merchants and so have to collect it themselves.

4. All participants in group discussions stated that they had to travel ever increasing distances to collect wood.

5. It was frequently stated that times had recently changed from when wood was free and easily available.

6. All the interviewees were aware of the spiralling increase in the cost of wood and this was not due to transport costs alone. Prices for headloads have sharply increased over the last few years.

7. A factor indicating a limited supply of wood is the highly controlled and selective access to the few existing woodlots.

8. Most people still rely on wood as their major fuel but, due to its shortage, are being forced to utilize very expensive 'luxury fuels' such as coal.

The participants in the interviews stated that their priorities with regard to fuelwood are:

1. First, cheap, if not free access to wood : this is believed to be a traditional right

2. Second, rights of access to woodlots without

hindrance

3. Third, a supply of wood situated close to their homesteads.

Most of the poorer people indicated that they were content to carry on using wood as a major fuel as they felt that other energy sources and associated appliances were beyond their means, both now and in the future.

7.4.3. Approach to the Enhancement of Woody Biomass

In terms of the basic rural energy needs approach adopted by this project, a woody biomass management programme should be needs orientated, assist in community self reliance and be environmentally sound. The current situation of limited access to fuelwood in the UTL does not fulfill these ideals. An intervention strategy must provide reliable access to cheap fuelwood, so as to answer the needs of the poorest. This can be approached in a two-prong plan:

1. the first approach should involve community participation in a woody biomass management programme;

2. the second approach should be the formal implementation of agroforestry programmes in the UTL.

This plan will be discussed more fully in the next chapter.

CHAPTER 8 : PROPOSALS FOR WOODY BIOMASS MANAGEMENT AND AGROFORESTRY IN THE UPPER TUGELA LOCATION

8.1. A Woody Biomass Management Strategy

As in other rural areas in South Africa, landuse in the UTL falls into three categories: (1) grazing land, which is often treeless, but with a number of patches of self-seeded wattles of various sizes, (2) arable fields, which are cleared of all trees, and (3) homestead yards, with a few fruit trees.

Increased woody biomass production is possible in all three land use categories and at relatively low cost. As wood shortage is not seen to be a major problem by the decision-makers, i.e. the headmen of the UTL, an afforestation programme is not likely to receive much attention and could easily fail. If linked to a priority issue, such as rangeland management, however, a woody biomass management programme would have greater chance for success. The first priority for development in the UTL, as stated by the Tribal Authorities, is the provision of fencing to protect agricultural land from cattle. The woody biomass management programme could be related to the fencing programme in the same way as this was achieved in Swaziland.

Chiefs in Swaziland have established Grazing Demonstration

Areas in which areas with bad over-grazing and erosion are fenced off and a limit set on the number of cattle that may be grazed in those camps. The dramatic recovery of grass, improved quality of cattle, and improved woody biomass production has been noted. With support from the Tribal Authority, the areas of worst erosion and overgrazing could be identified and recommended for priority fencing and rotational grazing.

While reduced stock numbers lead to a rapid regeneration of woody biomass, there is also the problem that if this regeneration is not controlled, grass growth will be suppressed by bush encroachment, with resultant loss of grazing and community support. If properly managed, with annual thinning of bush on improved grazing areas, a sustained supply of fuelwood and fencing can be supplied. At the same time possibilities for the gradual establishment of canopy trees in the rangeland are introduced. Close co-operation will be required with forestry extension officers to establish the number of cattle allowed to graze, and for how long, in the fenced camps. Rotational grazing would assist in vegetative recovery. Some fenced land may have to be removed from communal access, but if benefits can be seen to be derived from this practice by the community, this may not be a problem.

A strategy such as that outlined above must be carefully designed with close contact with the local communities. It is recommended that a pilot study be undertaken to determine and clearly demonstrate the advantages of a combined rangeland and woody biomass management scheme. The pilot study should also establish the likely effects of such a scheme on the women, the landless and poor, the livestock, and on the physical environment. The market potential of the wood derived from the scheme also needs to be established. Further study must also be done to identify precisely which sites should be fenced, how large they should be, and what procedures should be followed to maintain this wood production programme.

It must nevertheless be recognized that fencing will be expensive, and that fuelwood derived from this strategy may still be priced beyond the means of the poorest. Access to fuelwood might also not be made available to all in need.

The envisaged result of this woody biomass management programme would be a marked and rapid increase of fuelwood available in the UTL. There would be correspondingly less dependence on Natal farmers and the flow of money out of the UTL would be somewhat curtailed. Greater abundance of locally available fuelwood would limit the price of wood to within the means of most.

Increased vegetative cover and greater management of grazing will assist in the control of soil erosion in the rangelands which are, at the same time, the low access, high altitude areas of the Little Berg - environmentally the most sensitive. Control of erosion and conservation of the soil depend on the use of two sets of methods, the first are mechanical, which control the flow of water and therefore erosion. The second are biological, which aim to give the soil greater resistance to water action through vegetation and cultivation practices. Optimal land use and rational agricultural methods are the most effective way to conserve soil. These practices are, however, at present beyond the means of farmers in the UTL who cannot afford longer-term strategies.

It is important to develop a programme that will assist the farmers by being low cost, low maintenance, has high yield for low input and which has social feasibility.

The major costs in such a woody biomass-reduced grazing strategy would be the price of fencing and the cost of labour. Trees would not have to be purchased as regeneration would occur naturally. Additional planting of **A. mearnsii** seeds to speed up the production of seedlings would also be possible. Because of the present success of **Acacia mearnsii** in the area it is possible that this species would become the dominant regenerative species. As the woody biomass production will be contained, in terms of this strategy this alien species should not pose a threat to indigenous vegetation.

8.1.1. An Appropriate Wood Species

Acacia mearnsii appears to be an appropriate species because it meets almost all the requirements for an efficient fuelwood and has additional advantages. It is a vigorous pioneer plant, and pioneer plants favour disturbed soil and overgrazed areas. Such areas are common in the UTL. **A. mearnsii** also contributes to soil stabilisation while providing fuelwood. (It is ironic that this maligned exotic species might contribute significantly to environmental conservation as well as to the improvement in the quality of life in the UTL.) **A. mearnsii** clearly grows well in the UTL and the large seed-bank already established in the soil would facilitate natural regeneration and cut down on the expense of raising tree seedlings.

Further positive attributes of **A. mearnsii** as a fuelwood are its high woody density and its low moisture content. It is a fast growing coppicing species and produces small and large diameter poles. **A. mearnsii** also has a high calorific value, has no odour or allogenic constituents while burning, and importantly, **A. mearnsii** is a species which is already being used by the community and will therefore require no introduction.

8.2. An Agroforestry Strategy

Wherever attempts have been made to establish agroforestry by sacrificing crop production for wood production they have failed (Kang et al, 1984). This fact was alluded to by women interviewed during the informal group discussions in the UTL. These women indicated that they were not allowed to plant trees as this would reduce valuable agricultural land.

Techniques have nevertheless been developed to produce wood, not only without loss but in many cases with gains in production of food and fodder. Kang et al (1984:17) state "Agroforestry, the growing of trees on and around farms, aims to preserve the capital and draw on the interest. It is exemplified by living fences around compounds or irrigated plots to produce wood or fodder, instead of dead fences that consume wood". Kang et al mention wind breaks and alley cropping as two forms of agroforestry.

8.2.1. Wind Breaks

In Nigeria, studies indicate that crop yields were up by 18 to 23% after the introduction of trees into cropland. In the Majia Valley, wind speeds can reach up to 60 km per hour with resultant soil loss. Seedlings become buried in sand, and there is moisture loss and breaking of crop stalks. In 1974, wind break trees were planted in double rows, 4m apart with 100m between one line and the next. By 1984, there were 330 km of such wind breaks providing both fuelwood and soil protection (Kang et al, 1984).

One reason for the success of this project was local participation. The programme quickly won farmers' support once the improved crop yields were observed. "The benefits in wood production come as a welcome bonus, as fuelwood has become a marketed commodity in this heavily deforested area" (Kang et al, 1984:17).

Diab (1986) has identified the UTL as an area of high wind speeds. It is therefore an area which would probably benefit from wind breaks. Increased crop yields could be an incentive to local farmers to plant live wind breaks around their fields. Facilitators could encourage planting of trees along roads and around homesteads. A variety of tree species such as **Casurina**, Cedars, **Pinus**, **Grevillea**, Eucalyptus or even black wattle, could be planted as wind breaks (Gandar, pers. comm.). These trees could be managed as sources of fuelwood by harvesting them a row at a time. Fruit trees could be established around homesteads. Seedlings could be made available from the local forestry department, either free or at cost price.

8.2.2. Alley Cropping

Alley cropping was developed in 1976 at the International

Institute of Tropical Agriculture by Kang and his colleagues (1984). The technique reportedly began as a response to the failure of earth embankments and chemical fertilizers to solve the erosion and fertility problems of soils at the Institute's head quaters in Ibadan, Nigeria. Kang et al (1984:19) state:

> "The basic system is simple. Leguminous trees like **Sesbania sesban**, are planted in rows, at 4 to 10 trees to the meter. Crops are grown in 4 to 8 meter alleys between the rows. The seedling trees are weeded and protected along with the crop. During the dry season the trees continue to grow on residual moisture. At the beginning of the next rainy season, the trees are pollarded to a height of 1 to 2 meters, and pruned up to 5 times to avoid shading the growing crop. The cut wood can be used for fuel or poles. The twigs and leaves are dug in, applied as surface mulch, or used as livestock fodder. When the next dry season arrives, the trees are allowed to shoot up again".

The benefits gained from alley-cropping are multiple. Alley cropped soils are higher in organic matter and usable nutrients and have higher soil moisture levels. Crop yields are also higher and one can therefore anticipate greater farmer participation in an alley-cropping project. The economic costs of establishing and maintaining alley-cropping are negligible although labour input is relatively high due to pruning, "but pruning yields fodder and fuelwood, which would have cost extra labour to gather" (Kang et al, 1984:19).

Benefits from alley cropping, additional to its value as an energy source, are that there is enhanced soil conservation because of the increased organic content in the soil resulting in less erosion-vulnerable soil. But the greatest value of alley cropping is that it allows continuous cropping and improved yields, with no outside inputs. "It is the most promising technique for sustainable, affordable intensification of agriculture in the humid and subhumid regions. It is highly flexible and compatible with traditional cultivation methods, yet can incorporate chemical fertilization easily" (Kang et al, 1984:20).

In theory, agroforestry techniques such as live wind breaks and alley-cropping have great potential in the UTL. There are at present agroforestry trials being conducted in the UTL (Bristow, in prep.). Agroforestry techniques are compatible with the basic rural energy needs approach, as well as the entire UTL development initiative for the following reasons:

1. Agroforestry would assist in improving the affordability of energy sources in the UTL simply by increasing the local production and supply of fuelwood. An increase in the local supply would result in fuelwood

becoming a marketable product which, owing to competition, should keep prices to a level which could be afforded by the poorest.

2. An increased availability of locally produced fuelwood should decrease the dependence on fuelwood supplied by Natal farmers.

3. A general and increased supply of fuelwood would result in less selective access to limited stocks of locally grown fuelwood. The poorest would be benefitted.

4. A basic rural energy needs approach implies a reorientation of peoples' relationship with production and the natural environment. Agroforestry reflects this reorientation in that the relationship is mutually sustaining and dependable. This method of energy production would be both socially and environmentally appropriate. Conservation priorities would be addressed by decreased vulnerability to soil erosion in the UTL.

8.3. An Institutional Infrastructure for the Supply of Fuelwood to the Upper Tugela Location

It is apparent from observations during field work conducted in the UTL that there is little formal organisation for the efficient provision of fuelwood to inhabitants in the UTL. Those institutions that do exist are generally haphazard, and benefit the relatively wealthy. Baidya (1985:205) believes "it is necessary to emphasize that failure, in most cases, in development activities in the developing countries is due, not to technical or innovational causes, but to lack of institutional change. Policy programmes should avoid benefits mainly going to the richer sections of society." The quality of existing institutions, or the lack of them, are the primary limiting factor to successful development. What is needed is to create institutional developments first, says Baidya, and the technical developments will follow naturally.

> "The proper seed, fertilizer and machine use no doubt is relevant and important for enhancement of production, but what ultimately matters, is the distribution of the produce, so the effects be felt generally. This possibility can only be realized when the politicians and bureaucrats introduce reforms and improvements to remove the current institutional barriers. The same is true in our present consideration of fuelwood. Decisions as to whether one plants Eucalyptus, or **Leucocephela** are

quite trivial in the long run. This does not mean that we should not suggest planting of suitable species. But the planting of suitable trees should be seen as an adjunct to the institutional change, rather than the main activity." (Baidya, 1985:206)

To set up institutional arrangements, it is necessary to know who controls land, who is permitted to use nonprivate land, who benefits from that use, and who will pay the costs of such use. Most importantly, it must be made clear in the developmental agenda who is to benefit from improved services. Throughout this project, it has been stated that for a rural energy strategy to succeed, the needs of the poorest have to be addressed first. There is always the risk that the vested interests of the more wealthy and powerful of the community might highjack a well-meaning but naive development strategy.

A lesson learnt from previous afforestation programmes is that benefits go mainly to the richer sections of society and that "in reality none of these programmes is helping to increase the production of firewood. The increased supply goes to those who can pay" (Baidya, 1985:206). Baidya maintains that a second 'green revolution' may happen through afforestation programmes, resulting in considerably increasing energy production, but that the poor will still lack fuel. "We must consider the equity, distribution and mechanism of monitoring, by which the gap between the well-off and the poor can be minimised" (p. 206).

Baidya (1985:207) makes clear distinctions between technique, technology and institutions in terms of defining approaches to the development of afforestation programmes. Each one attempts to satisfy the objective of common interest for public purposes. Technique represents the physical capacity of a society. It consists of the machines, the physical inputs and the knowledge that show how physical objects are to be combined and utilised. A technique represents the specific manner by which humans interact with their physical surroundings.

Institutions are created by collective action in restraint and in liberation of individual action. Institutions indicate or determine what individual members of a society can and cannot do. "Institutions represent the existing conventions, rules, norms and habits that define individuals in relation to others in the society and the individuals with respect to power" (Baidya, 1985:208).

The value of these distinctions is that they illustrate the need to plan a woody biomass management strategy with due regard for social considerations.

> "Social forestry plantation is a technique, with reference to questions of what species are to be planted, what space between plants, on what type of soil, rainfall and climatic conditions. But when combined with institutional arrangements that determine who will get what on a percentage

CHAPTER 9 : CONCLUSION AND RECOMMENDATIONS

Carlson and Harman (1982:5) state that

> "few societal decisions rival in complexity and difficulty the contemporary decisions on energy. Every decision to alter price relationships among competing energy sources, or to adopt a policy affecting energy demand or choice of energy form is a step toward the ultimate societal choice of what the shape of the final energy system shall be."

'Choice' means the decision rural people make to decide which energy sources are most appropriate to their needs and financial means. The optimal situation for rural energy utilisation would be the freedom of rural people to choose and utilise the energy sources most suited to their needs. This, however, would be an ideal situation. Chapter 7 has suggested that clean, renewable sources of energy such as the sun and wind are not the most appropriate options for an integrated rural energy strategy for the UTL at this stage of development. This may change in the future.

The next best option would be for rural dwellers to have the freedom to choose from a selection of available and appropriate energy sources those most appropriate to their needs and financial means. The development planner cannot make that choice for them and should not attempt to do so. The development planner should rather act as an expertise resource, advising rural people what the realistic range of options are.

Foley and van Buren (1981:4) state that the level of energy uses, the kind of fuels and appliances utilised and the nature of the supply system are all characteristic of a particular level of development. These characteristics are indicators of development rather than causes. If this is so, providing an additional energy supply will not necessarily bring any benefits. Before any policy initiative on energy supply is taken, it is therefore necessary to examine the constraints on effective energy supply imposed both by the context and by the energy technology itself. This study has attempted to develop an integrated rural energy strategy for the UTL by addressing integration at two levels. The first level is the policy level.

The policy or theoretical level is an attempt to examine both the socio-economic and technological constraints on optimum energy supply in the UTL. The basic rural energy needs approach adapted from Lisk's (1985) theory of basic needs has provided the means to develop three principles for planning an energy strategy in the Upper Tugela Location.

It has already been shown that while household fuelwood consumption in the Upper Tugela Location is low, approximately 3000 kg per annum, wood will remain the primary domestic fuel in the UTL for the forseeable future. Eberhard and Dickson (1987:77) state unequivocally that "the overall strategy for meeting the domestic energy requirements, particularly for cooking and to a lesser extent space and water heating in the rural areas, must focus on afforestation." While these authors were referring to conditions in Bophuthatswana, this statement is pertinent for the UTL as well. At the same time, Foley and van Buren (1981:5) warn that as long as women are excluded from money transactions, they have no access to commercial substitutes for wood fuels and will continue to use fuelwood resources which they will attempt to obtain as free goods. This results in the 'tragedy of the commons' in which the fuelwood resources become depleted as there is no ecological or social mechanism which will ensure replacement. "When wood is gathered as a free good from common land, no individual has the incentive or responsibility to replace trees" (Foley and van Buren, 1981:3). While women in the UTL do have access to imported commercial fuels, an inordinately large portion of their limited income is spent on purchasing these energy sources.

The second level of integration is aimed at the programme level by suggesting that no one technical option will address all the energy requirements of the study area, but that a combination of options implemented over time will create a flexible energy strategy that should accommodate the needs of all the people living in the UTL. This study recommends that:

1. The woody biomass management and agroforestry programmes should be implemented as soon as possible.

2. Solar and micro-hydro power should be introduced once these technologies become cheaper and more dependable.

3. The feasibility of providing electricity from the national grid should also be further explored.

4. The local distribution of commercial fuels in the Upper Tugela Location should be improved without delay.

Care has been taken in the attempt to structure a strategy which: (1) allows for the creation of a marketable commodity from fuelwood, thereby providing the means to a more affordable source of energy, (2) enhances the local production of the dominant energy source in the UTL, i.e. fuelwood, thereby potentially increasing its availability to the poor, (3) lends itself to community organisation and institutions so as to ensure improved access to fuelwood for all the people of the UTL, (4) requires relatively less organisation and expense than traditional formal afforestation techniques, (5) offers employment opportunities to unskilled labour in the UTL, (6) is compatible with current life styles and practices in the UTL, (7) is compatible with the development initiative for the UTL, (8) is compatible with the concepts of environmental conservation and natural resource management, and (9) allows for the integration of further energy development in the future.

The proposals for woody biomass management and agroforestry outlined in this study attempt to address the needs of the poorest. For a rural energy strategy to be integrated, however, other sectors of the communities living in the UTL should also be considered. The introduction of national grid electricity may not be feasible for the poorest, but there are more wealthy homesteads, successful farmers, small businesses or community services which could possibly afford it and they have a right to it. High quality sources of energy such as national grid electricity or micro-hydro power units should not be rejected from the energy strategy but their limitations for the majority of people living in the UTL should be recognized.

> basis of the produce, and when it is to be harvested then we have social forestry technology. This includes the cultural practices, the land tenure, the physical and financial inputs in the system, in addition to the planting technique. Under any given technical structure, it is the institutional arrangements that foster economic change and development" (Baidya, 1985:206).

The issue of equitable access to resources is perhaps one of the most polemic and nebulous of development problems. There are no safe-guards that can be built into a development strategy which could, over time, prevent local power hierarchies developing, ultimately marginalising the poor once again. The best a development strategy can do is to acknowledge the power of local democratically elected institutional infrastructures which may, hopefully, control equitable access to resources, and to encourage these in the development strategy. As an example, if the woody biomass strategy outlined in this study were initiated in the UTL, representative institutional structures would be needed independent of political structures, whereby distribution points and prices for locally produced fuelwood could be agreed upon. This form of institution could work in close association with local facilitator and forestry extension officers to ensure controlled and sustainable management of the fuelwood resource.

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APPENDIX 1

An example of the data sheet used to record daily observations during visits to the Upper Tugela Location.

Location Bonjaneni **Date** 10/6/87 **Time** 9.20 a.m

	Number
No. of houses connected to overhead electricity cables	1 (butcher/bottle store)
No. of houses with rooftop solar panels	1
No. of open fires observed	0
No. of women carrying fuelwood headloads	0
No. of women seen chopping wood	0
No. of woodmerchants seen	1
No. of coal merchants seen	0
No. of formal woodlots seen	1

Other

1 house with car battery-operated TV + Radiogram.

Table 1 : Mean annual domestic fuelwood consumption of some rural areas in South Africa

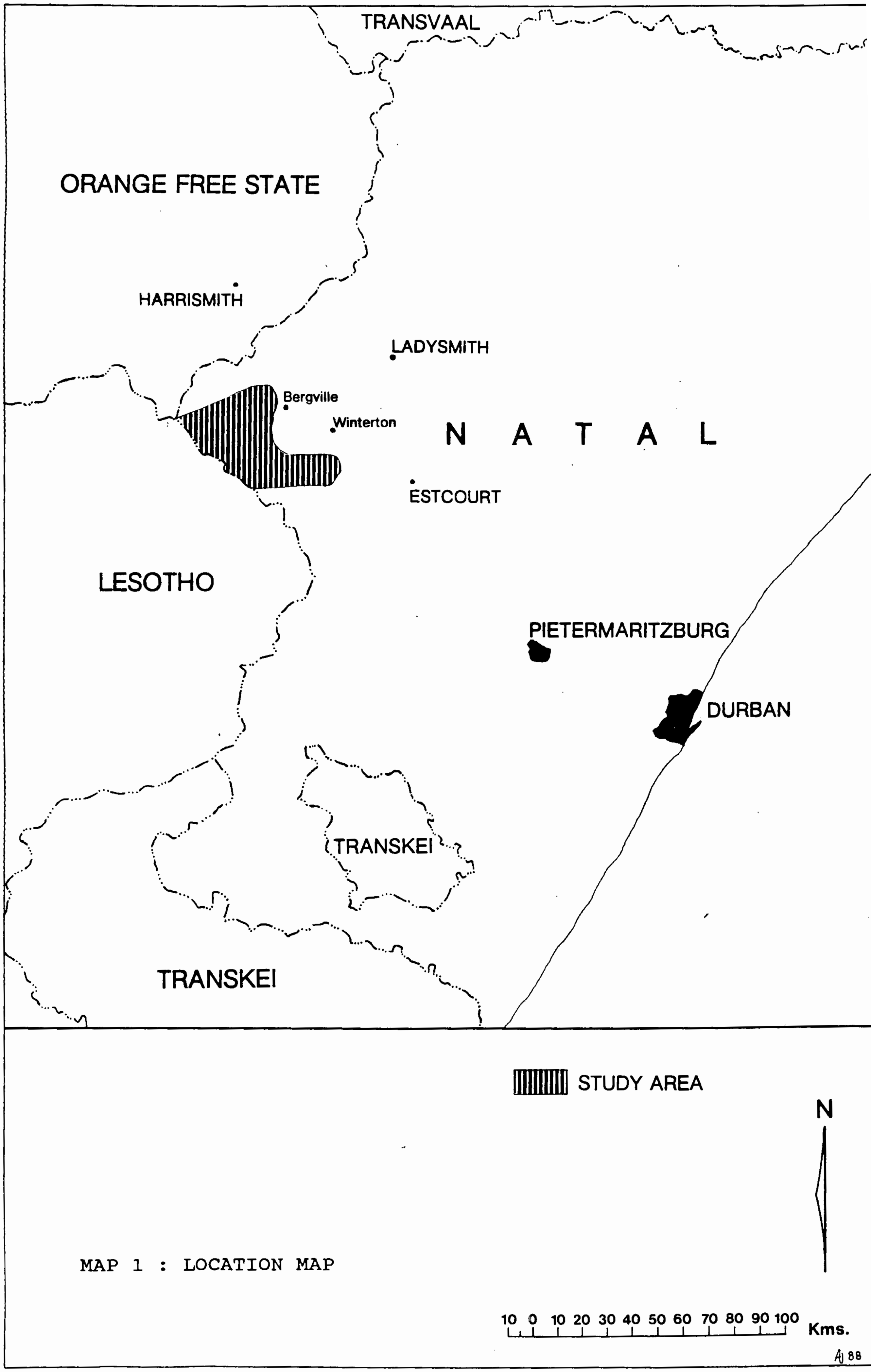
	Kg/household	Kg/capita	Source
Mahlabatini, KwaZulu			
valley lowveld	7700	740	Gandar (1983)
high grassland	4800	620	Gandar (1983)
Malefiloane, Lesotho	1500	*	Best (1979)
Jozanna's Nek, Transkei	1705	271	Best (1979)
Mashunka, KwaZulu	4824	1124	Best (1979)
Bodibe/Springbokpan	1387	237	Eberhard & Dickson (1987)
Madutle/Mogosane	2124	302	Eberhard & Dickson (1987)
Dinokana	2530	375	Eberhard & Dickson (1987)
Ganyesa	1223	297	Eberhard & Dickson (1987)
Deerward	2792	485	Eberhard & Dickson (1987)
Loopeng	3978	772	Eberhard & Dickson (1987)

* not available

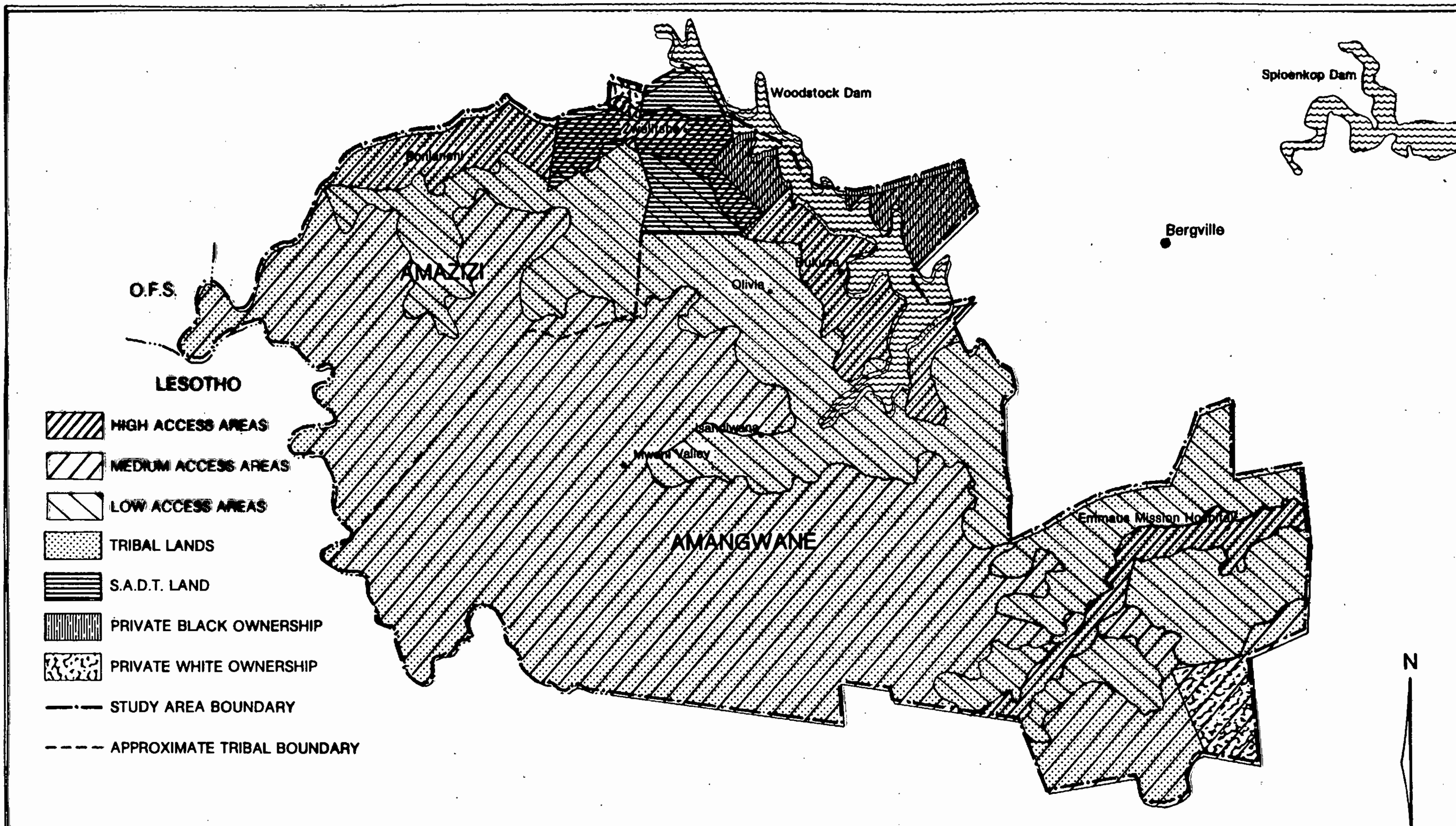
Table 2 : Cost Comparison of Electricity, Gas and Solar Power

COST SUMMARY (APPLYING CURRENT TARIFF D1)								
ITEM	COST IN RAND							
	DWELLING No 1		DWELLING No 2			DWELLING No 3		
	Elect	Gas	Elect	Gas	Gas/Solar*	Elect	Gas	Gas/Solar*
Required Capital	1510.00	527.06	2785.00	1456.00	3691.12	5554.04	4770.00	6874.40
Capital Repayment	35.92	12.54	66.25	34.63	87.81	132.13	113.48	163.54
Running Costs/Mth	110.62	67.35	146.15	99.52	72.07	189.91	136.20	122.70
Total Bill/Mth	146.54	79.89	212.40	134.15	159.88	322.04	249.68	286.24

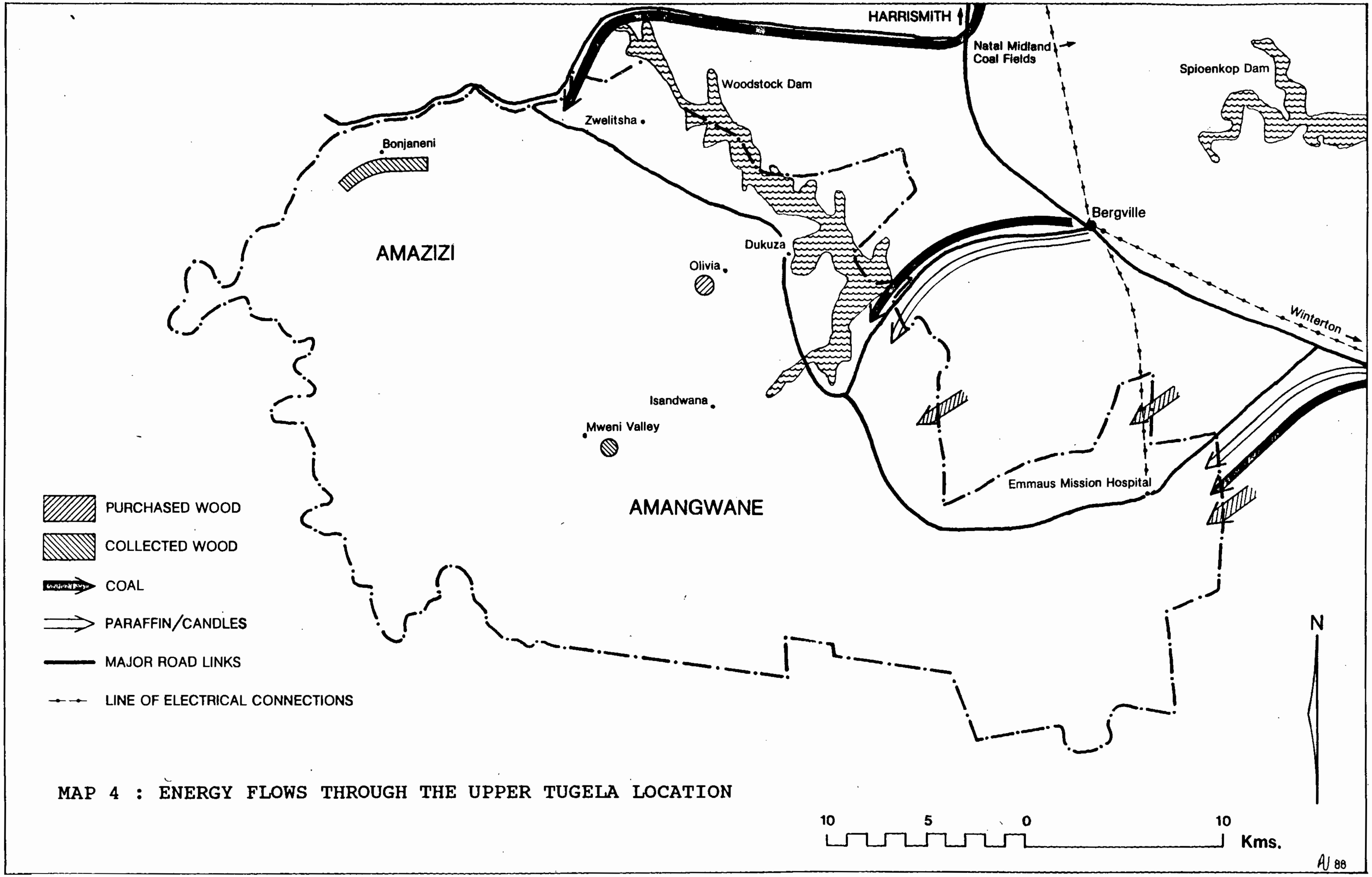
* NOTE: The Solar Panel is used for lighting and powering the T.V. set.



MAP 1 : LOCATION MAP



MAP 2 : LAND TENURE AND TRIBAL GROUPS IN THE UPPER TUGELA LOCATION



MAP 4 : ENERGY FLOWS THROUGH THE UPPER TUGELA LOCATION