SUPPORTING INNOVATION IN THE DELIVERY OF ENERGY SERVICES
TO THE RURAL POOR:
OFF-GRID ELECTRIFICATION VIA CONCESSIONS IN RURAL SOUTH AFRICA

Solar electrification by the concession approach in the rural Eastern Cape

PHASE 1. BASELINE SURVEY

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ENERGY RESEARCH CENTRE
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EXECUTIVE SUMMARY

The Energy Research Centre (ERC) at the University of Cape Town is in the final stage of a three-year research project monitoring, evaluating and supporting non-grid energy service delivery in three remote rural areas in South Africa. The rural non-grid electrification programme, which was initiated by the South African Department of Minerals and Energy (DME) in 1999, seeks to widen access to electricity. The programme adopted the energy services company (ESCO) model using the fee-for-service approach. The ESCO model grants private companies concessions to establish non-grid energy service utilities that install and maintain non-grid technologies for household use, supported by a government subsidy.

A team of researchers conducted field studies in three of the five concession areas. These concession areas are located in the north-eastern corner of the KwaZulu Natal Province known as Maputaland, the northern part of the Limpopo Province and in the northern part of the former Transkei in the Eastern Cape Province. Ongoing research in the concession areas has been undertaken since May 2001. One objective of the field research was to assess the initial social impacts and service delivery of the SHSs in the rural communities and communicate the findings to the relevant stakeholders.

This report is the first of a series on the impact of solar home systems in three provinces of South Africa. It provides information drawn from interviews with the Department of Minerals and Energy (DME) and the National Electricity Regulator (NER), the non-grid service providers and interviews with 681 households. Part 1 of this report introduces the operations of three energy service providers along the "fee-for-service utility model". The three initial concessionaires and their customers are the subjects of the research that was conducted by the University of Cape Town. They are Eskom-Shell in the Eastern Cape, Nura in KwaZulu Natal, and Solar Vision in the Limpopo Province.

Each concessionaire has specific characteristics, its ways of implementing and installing non-grid electricity through Solar Home Systems and its own set of problems.

This first report concerns primarily the delivery of non-grid electricity in rural Eastern Cape and measuring the impact of solar systems on households themselves. Two further reports deal with the findings from surveys in the KwaZulu-Natal and Limpopo concessions, which will be published later.

To each of these initial reports will be added a supplement in which the results of follow-up surveys conducted two years after the first survey are presented.

A final summary report will compare and contrast the findings drawn from analysis of the data concerning the three service providers and their customers.

Part 1 reviews the early development of government policy aiming at "*electricity for all*" making the delivery of solar electricity an integral part of the electrification programme.

Part 1 should in no way be seen as exposing the early mistakes of service providers but rather as laying a foundation for lessons from which other similar non-grid electrification utilities could learn in their implementation processes especially since more and more developing countries are looking to the fee-for-service model for delivering electricity to remote rural areas. The difficulties encountered in the early days of service provision were a necessary learning process in order to make the companies and their management better adapted to the problems of a specific task and environment. Important organisational and operational restructuring of companies took place in the early years to meet organisational and technological problems as they became evident.

Each of the other four service companies developed independently in a similar pioneer fashion until more recently they formed an association through which the exchange of information, experience and know-how can take place.

Part 2 of this report presents the analysis of results drawn from face-to-face interviews with 348 Eastern Cape households, the majority of which were solar home system users. The survey data were collected in June 2001. A small number of grid electrified households, living in the same areas were interviewed as a control group and a small number of households without any electricity were also interviewed as proxy for a truly "before and after" study which had not been possible to undertake.

1. Institutional and contractual arrangements

The "fee-for-service" model on a large scale developed only after the DME had in 1995, established a company called RESA Ply which was conceived for a credit based large-scale delivery of non-grid

systems in rural areas. The delivery of the necessary infrastructure in deep rural areas rendered this particular project unfeasible and uneconomic. It however, generated new ideas around a "fee-for-service" model that could be delivered by privately owned utilities.

It was expected that the service providers would adopt a delivery model that promoted a range of fuels such as gas and paraffin in addition to SHS or mini-grids. The fact that this has not yet happened in most of the service providers areas, points to the inherent difficulties of reaching such objectives

The geographic areas allocated to each service provider were broadly defined and included areas with access to grid electricity. The non-grid providers were to target small pockets in broader areas, to be identified annually in consultation with the appropriate grid and service authority particularly Eskom and Durban Metro.

The research presented in this and the supplementary report shows some of the difficulties these arrangements created for the service provider and customers alike. In some cases in the Eastern Cape, the unanticipated arrival of grid electricity has necessitated the removal of solar home systems currently at the expense of the company. There are discussions with the DME for compensation for these removals.

It is the responsibility of the NER and the DME to establish a regulatory framework for the non-grid programme and also to regulate prices, technical and customer service standards and management of disputes.

Subsidies for the capital costs of the non-grid electrification were provided through the National Electrification Fund, which was to be administered by the DME. The selected non-grid service providers were to have exclusive rights to receive subsidies for non-grid electrification in particular geographic areas for a period of five years although the non-grid service contracts are to remain in force for a period of 20 years. The first five-year pilot period draws to a close in March 2004.

2. The concession areas

The North Eastern area of the Eastern Cape where Eskom-Shell operates is one of the most deprived areas in the country with difficult geographical terrain making the maintenance and repairs of the SHS presenting some challenges and arguably opportunities for innovation for the ESCO. Similarly, customers living in these areas have to traverse the same difficult terrain when making their monthly payments or lodging complaints. The area of operation includes the rural towns of Bizana, Mount Ayliff, Flagstaff, Tabankulu, Mount Frere, Matatiele and Mount Fletcher. These small towns are situated in some of the poorest areas of the Eastern Cape.

3. The solar system unit

The solar energy service delivered by Eskom-Shell is packaged in a unit called the Power House with a power input rated at 50Wp from the solar panels. This system provides power for 3 inside lights, 1 outside light, 3 plug-and-play points for a radio, a black-and-white television and smaller DC appliances like cash till, although all of these cannot be used simultaneously given the limited output. Customers pay R110 for the installation of this system and a cellular phone charger accessory can be added for an extra R20. The Power House charge/discharge regulator and the battery are enclosed in a casing called the "tower". There is a smart switch on both the solar panel and the battery to protect the system against theft or tampering. The system also has a card reader that disconnects the system from supplying power when there is not enough credit on the inserted prepayment card. The battery is sealed to avoid any tampering by the user. CONLOG, the electronics hardware and software company in Durban, supplies the towers and the systems are delivered via Shell Solar South Africa in Durban. The batteries are supplied locally by First National Battery based in East London and the solar panels are imported from Amsterdam, The Netherlands. The relatively basic SHS technology is complicated by the anti-theft, anti-tampering and prepayment system mechanisms.

4. The fee-for-service payment system

Each SHS customer is expected to purchase a prepayment card or token for R58[1] from an outlet to last 30 days. In the event that the customer is unable to purchase a prepayment card after this period,

[1] The monthly service fee which is paid in exchange for a prepayment card was increased from R52 to R58 in 2002.

the smart switch turns the system off, disallowing the customer access to power. Not only is the customer denied access to the use of power from the system when unable to purchase a new card, the system also records all the days when the customer did not use the system as negative credit or days against the customer. Thus, when a new card is purchased by a customer who could not use the system for a number of days due to non-payment, the customer does not have access to the full 30-day credit on the card but rather the remainder when the negative credit is deducted. Payment for the service is compulsory even when it is not used. This is a "foreign" concept to many people accustomed to prepayment for grid electricity where if customers cannot afford to buy a new card they simply go without electricity for the days that they are unable to purchase credit for and are certainly not penalised for it through "negative credit". This is the fundamental difference between the two payment systems and requires careful consideration, particularly in impoverished communities. The fee-for-service system may result in the accumulation of a household "energy debt".

5. Services provided by Eskom-Shell

The services provided by Eskom-Shell to their customers include:

- the installation of the complete solar system, ensuring that the system is in good working order, ensuring that customer' complaints are attended to, replacement of lights, extension of wires for lights, connecting appliances to the system, maintaining the water level in the battery, cleaning the panels and relocating them when requested by the customer;
- the cost of these services is included in the monthly service fee.

6. Management of services and staff training

The initial phase of the installation process required a large number of trained people. An initiative on the part of Eskom-Shell was the recruitment and training of operational staff drawn from the local communities. Thus Eskom-Shell has initiated job creation and skills building in this deprived area.

In the early stages of the service provision, local entrepreneurs acted as Sales Managers for the 5 Rural Energy Service Companies (RESCOs) established in 5 towns within the service area.

Subsequently, in response to fraudulent dealings that had taken place, Eskom-Shell took control of the RESCO offices and appointed an Area Manager and a Clerk for each of the 5 rural areas. Their appointment was based from then onwards on the criteria specified by the company. A much tighter organisational structure was put in place. Each area was divided into zones of which there are 45 altogether. Each zone has 3 to 5 outlets that are mainly shops and spazas where the service prepayment cards are sold and maintenance problems are reported. Altogether, there are about 130 outlets servicing the whole area. From the installers initially contracted to install SHS, 45 were selected and trained as technical inspectors. Area Managers have the responsibility of weekly visits to the zone, delivering spares, and overseeing the maintenance and service problems.

Due to the technical and sensitive nature of the security protection system which had to be put in place to prevent theft or tampering, more skilled inspectors and a senior inspector were appointed and trained to deal with high-level complex maintenance problems. There has thus been an increasingly complex organisational structure adopted by the company but at the same time an increasingly skilled work force.

Part 2 of the report looks at solar electrification and the fee-for-service model from the customers' point of view.

The SHS fee-for-service model was the first of its kind in South Africa[2]. Part I of this report documents the many obstacles that had to be overcome before SHS units were finally installed in remote rural households. Government policy, the specification of role players, the allocation of responsibilities, the legal framework, all took time to develop. More than two years were "lost" in the initial phases of the project before the first solar home systems were in place and the fieldwork undertaken. Fieldwork involved extensive interviews with service providers and their staff, followed by interviews with households.

[2] The fee-for-service model has been developed in several countries namely Ghana, Brazil, Argentina, Peru and Zimbabwe amongst others.

7. The objectives of the household surveys

The objectives of the household surveys were ambitious. They included measuring the socio-economic impact of SHS on users over time, and detecting and measuring changes in fuel-use and expenditure as well as broader impact in the livelihoods of rural households as a result of the introduction of the new technology. This made it possible to explore the extent to which the "resilience of rural households", (that is their ability to survive) may have been affected by the solar home systems.

Part 2 of the report then deals with the results of a survey of 348 households. 232 of these were using a SHS, 51 were grid-users living in proximity to the SHS-users and 65 were households who had no access to electricity. These last two sub-samples were "control groups" as a proxy for a truly "before and after" impact study.

8. Characteristics of households surveyed

Though a large majority of rural households are poor, there are wide differences in the total income available to households. There is far more heterogeneity in household incomes than was initially thought.

SHS-users are on the whole, wealthier than the sample of grid-households and much wealthier than households without any electricity. The mean monthly income of SHS-users is R2307 compared with R1860 for grid-users and R819 for households with no electricity.

Per capita monthly income is highest for SHS-users: R542. For grid-users it is R402 and for non-electrified households, per capita monthly income is R169 per person per month.

SHS-users are likely to be better educated, have larger homesteads, have fewer household members and are far more likely to be regularly employed. These characteristics are a reflection of the quite strict selection process through which applicants for SHS must pass. This ensures that the customer is "able" to make regular payments and gives the service provider a certain amount of financial security. But this leads to an important question. To what extent are SHSs reaching the poor?

9. Installation of the SHS

The installation of SHS for the majority of users was relatively fast, certainly faster than for grid-users waiting for a connection. There is a relatively high level of satisfaction concerning the actual technical installation. 72% of households said they were satisfied with the work of the installers and for those who were not, the explanation was generally that the system was not yet working properly.

10. Customer "satisfaction" and ambivalence

Section 5 of the report concerns classic measures of "customer satisfaction" compared with individual questions that permitted households to say what was wrong. Many SHS-users are ambivalent about their solar system as a whole. They are indeed pleased with the 4 lights that come with the system even though a common complaint was that they needed more lights for the "other" rooms, there are improvements in that they can watch a small TV (without having to use a car battery), they have a radio although the majority already had radios, the children have improved lighting for study, but they are in some important senses quite alienated from their system. Customers don't own their system (although 17% think they will, in time, be owners of the system). The service provider takes full responsibility for the maintenance of the whole system including replacing light bulbs, which leaves the customer with few ways of getting to know the system or what to report when things go wrong. At the time of the survey, large number of customers didn't know how to check the credit that is left on their system. There has been little transfer of solar technology knowledge to these households

Furthermore, customers were left in ignorance about the subsidies provided by the government. Few were aware of the R3500 capital subsidy or that this was a government initiated programme. In the follow-up survey, some customers were aware of the promise of an operational subsidy. That they had not received it at that stage, increased criticism of the cost of the fee-for-service that the majority of users find too expensive.

11. Problems with the solar system

The fact that two thirds of the SHS households interviewed had had problems with the system and that there were delays in getting it repaired dampens the enthusiasm for solar power. Three other factors weigh heavily on customer's appreciation for the SHS. These are:

- the cost of the token;
- limitations on what appliances can be used;
- the cost of all other fuels that must be purchased, despite having solar power.

12. Cost, limited power capacity and the cost of other necessary fuels

R58 a month is thought to be too expensive by the majority of SHS-users. When compared with grid households, SHS-users are paying considerably more per kWh and for a much lower power capacity than are grid-users. 55% of SHS-users would be willing to pay more for a larger system. The reasons given were that thy wanted lights in more rooms and they wanted colour TV. Many households in fact, had expected to be able to use appliances such as a stove with their solar equipment. 54% own electrical appliances they can't use with the solar system.

13. The cost of fuels

All households, whether solar-users, non-electrified or with grid electricity are spending monthly a considerable amount of money on fuels. Only 20% of grid households use electricity for cooking. The dependency on paraffin, wood and gas for all household needs (such as cooking and water heating) means that large amounts of these fuels have to be purchased. The average (mean) spending per month on all fuels, excluding electricity, is highest for SHS-users. They are spending on average R157 per month on all fuels compared with an average of R102 for grid-users and R133 for households without electricity.

The cost of return journeys to buy fuels adds considerably to the cost of the fuel itself and this has not been considered in the above comparison of fuel expenditure.

There are very large differences in the prices households are paying for all the fuels they buy. Poorer households are penalised for having to buy smaller quantities more frequently.

Households are almost unanimous in the preference for using electricity "should they have the opportunity" although research shows that some still resort to fuel wood in spite of being electrified. A very important difference is that non- and grid-electrified households are able to vary their energy use and expenditure, whilst solar electrification via the fee-for-service model means that they are locked into the monthly payment irrespective of their income.

14. Changes in fuel-use after receiving solar energy or grid electricity

Most SHS-users state that they are using less fuel – but not fewer fuels – since obtaining the SHS. The percentage of grid-users affirming this is far higher. SHS-users are still obliged to buy candles or use paraffin for lighting rooms where there is no electricity. They are still obliged to use other fuels for cooking, ironing, and water heating.

15. Changes in people's lives

The most frequently stated life-changes for households following the installation of a solar system is the use of lights and the possibility of watching TV. 60% of households agree that solar power has changed something in their lives. Lights and TV are without doubt greatly appreciated. However, these changes are small in comparison with the impact of grid electricity as expressed by those who now have grid electricity. All such households (100%) say that electricity has changed their lives with 43% stating that their living standards have been improved.

SHS users have perhaps more contact with the out side world, through the TV and radio and children have better light for homework. The real impact of these kinds of changes however, can only be measured over time.

96% of grid-electrified households would recommend others to get grid electricity. Only 57% of SHS-users would do so. Indirectly, this measures how the pros and the cons of solar have been weighed and evaluated by the households interviewed.

A concluding remark in the report and perhaps the most serious criticism of the present delivery of SHS is that SHS do not reach the poorest of the poor. SHS-users are the wealthiest of the three sub-samples interviewed. Those without regular employment, those with little regular income are presently excluded from benefiting from solar electricity.

Key issues identified

Social changes brought by innovations such as solar power are small and imperceptible and probably only cumulative in the presence of other catalysts. Could a service provider on a bigger scale, delivering not only solar systems but also all fuels required by the household be such a catalyst?

Households need to feel part of the changes in their livelihoods. Presently SHS-users are *not* encouraged to do so by the fact that they don't own their system, not even after years of paying the service fee. They have even no right to touch the system. Could this be changed in the future? What difference in the opinions of households might come if progressively and over time, they were to acquire ownership of the system that they could sell when they finally had a connection to the grid?

Some structure or organisation should be developed which would clearly represent the interests of customers of service providers.

Customer services provided by the service providers will have to be improved considerably in the future. This will include regularly informing customers of changes in Company policy and building some kind of incentives for better payment and better care of the systems.

Maintenance and technical staff will have to be located closer to SHS-users homes and their numbers increased to avoid delays.

The "image" of service providers needs to be strengthened. RESCO centres and outlets are often almost "invisible" except for the discerning eye. Interiors of these offices are important – even in outlying rural areas.

All effort should be made to encourage households with SHS to generate income using their solar system.

It seems probable that in the future it will be necessary to develop a policy of subsidizing only the poorest of the poor for solar home systems.

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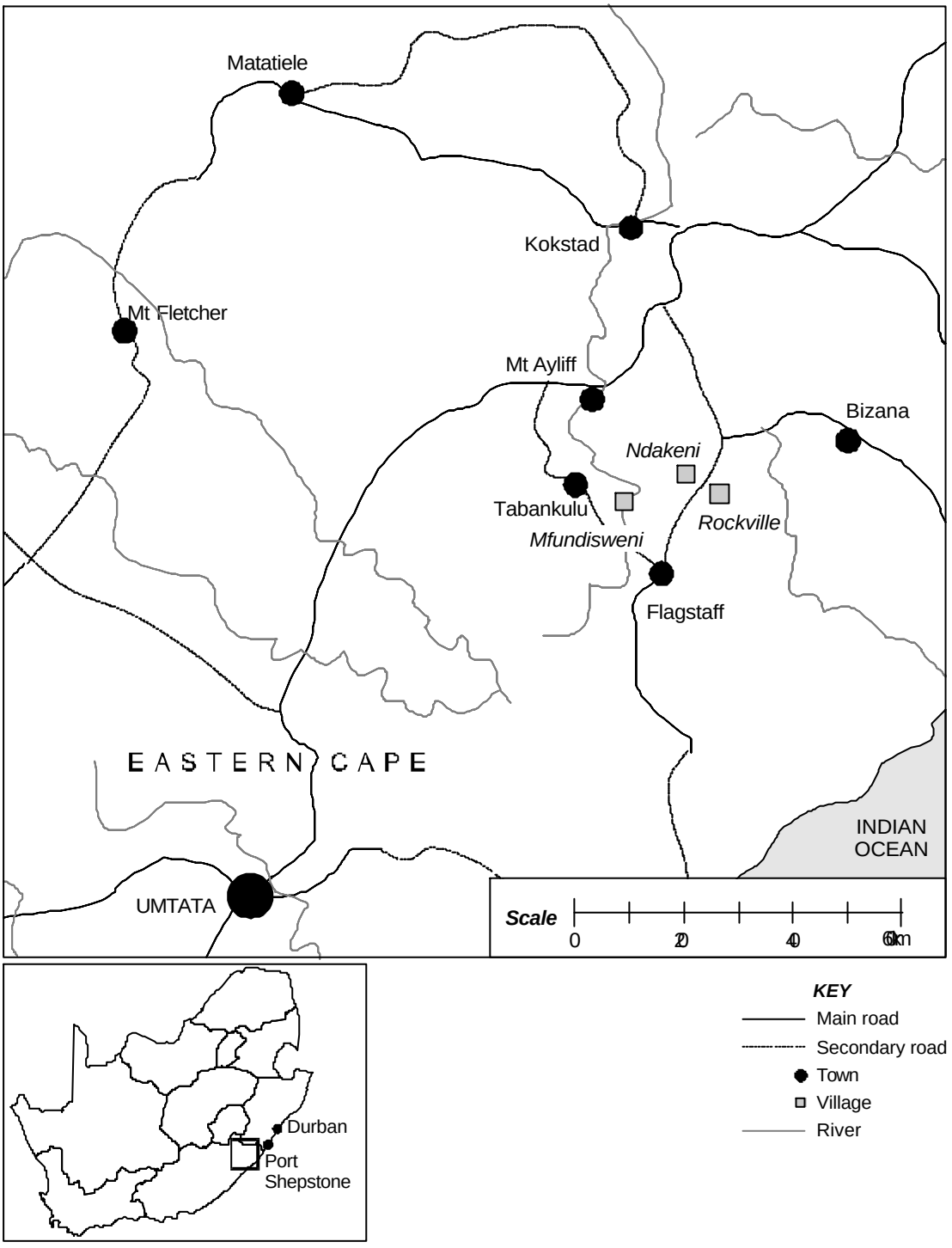
Abbreviations and acronyms used

SHS	solar home system
PV	photovoltaic
DME	Department of Minerals and Energy
NER	National Electricity Regulator
Wp	Watt-peak
RESCO	rural energy service company
NECO	National Electrification Co-ordinating Committee
ESCO	energy service company

Map of the Shell-Eskom concession area



PART 1

1. Introduction

This study is based on interviews, household energy surveys and fieldwork undertaken in the non-grid electrification service area of Eskom-Shell Joint Venture (Eskom-Shell) in the north-eastern portion of the Eastern Cape Province (in the former Transkei area). The fieldwork involved extensive travels within the area of operation and interacting with and interviewing the utility management and operational staff, as well as talking to community role players and a considerable number of end-users of the service. It also involved participation in a community meeting organised by the utility. Two field visits were undertaken in May and June 2001 with each visit lasting for about a week. The second visit mainly focused on an elaborate survey with the purpose of monitoring the socio-economic impacts of the non-grid electrification programme on the communities and all the findings in this report are based on the results of the analysis of the first survey data. In some cases, however, general impressions gathered from the various discussions and observations during the field visits are used to support the results from the data analysis.

It must be stated clearly here that the open and transparent manner in which the management of the Eskom-Shell shared information about their operations was very impressive and the support offered by the Eskom-Shell field staff to the research team contributed a lot to the understanding of their operations. Since the non-grid utility approach is an innovative model never tried in South Africa, the Eskom-Shell appear to be "guinea pigs for the experiment", making all the mistakes for others to learn from. Thus, this study should not be seen as exposing the early mistakes of the Eskom-Shell but rather laying a foundation for lessons from which other similar non-grid electrification utilities could learn in their implementation projects.

1.1 Background on rural solar electrification: Why rural solar electrification?

In this section primary drivers for the non-grid electrification programme are explored. The first is the accelerated (Phase 1) National Electrification Programme rolled out between 1994-1999, which sought to widen access to electricity in rural areas. When it became clear that remote rural areas would not be reached in the medium term, non-grid technologies were perceived as an attractive electricity delivery mechanism. The second driver is the global promotion of these non-grid technologies as a clean energy source, particularly by certain funding agencies. Some of these agencies were instrumental in developing the South African government's policy regarding non-grid electrification.

In an effort to ensure access to electricity in rural areas and stimulate the renewable energy market, the government pursued the ESCO model with a fee-for-service approach. Five private companies were each granted concession areas to establish non-grid energy service utilities. The licensing agreement entitles the concessionaire to install and maintain non-grid electricity technologies in allocated rural areas. To date this has been limited to the provision of SHSs, producing electricity for household use. Currently, the government awards a subsidy of R3 500 to the concessionaire for each installation of a SHS, towards the capital cost – although the ESCOs claim that this does not cover all the costs. The government has therefore agreed that the ESCOs may charge each household a monthly service fee of R58 and an upfront installation fee of R100. The service fee covers the maintenance and servicing costs. The government has recently introduced free basic electricity to both non-grid and grid electrified households. The non-grid electrified households will receive a subsidy amount of R40 (paid to the ESCOs) towards their monthly service fee. Grid-electrified households will qualify for a free amount of 50kWh or approximately R18 per month.

The new South African democratic government since 1994 made *universal access to electricity* one of its primary objective. This influenced the drafting of its energy policy in order to meet the huge expectations concerning service delivery including electricity (DME, 1998). A massive electrification programme under the Reconstruction and Development Programme (RDP) led by the national electricity utility, Eskom and the municipalities, achieved an increase in the national level of household electrification from 36% to about 68% by the end of 1999 (Kotzé, 1999). In the five years from 1994 to 1999 2.74 million new grid connections were made at a cost of about R7 billion as part of the accelerated national electrification programme, in accordance with the Reconstruction and Development Programme (RDP) targets agreed upon by the government and the electricity industry

(ANC, 1994). The RDP target of connecting 2.5 million homes from 1994 to 1999 was exceeded, with the total number currently at 3.75 million after ten years.. At the end of this programme, rural households' access to grid electricity had increased from about 10% to about 46% in 1999. However, although the percentage of rural households with access to grid electricity was 46%, this was in stark contrast to an urban household electrification level of 80% (NER 2000). It was decided that urgent redress was required in order to make good on an election promise of "A better life for all" which implied that each South African citizen is entitled to basic services like electricity. In meeting this commitment, the government was faced with the perceived high cost of extending the grid to rural areas, so that non-grid technologies were considered a viable option.

In the absence of a national energy policy, the Department of Minerals and Energy (DME) had relatively little control over the first phase of the electrification programme when it started and thus the National Electricity Regulator (NER) was made to fulfil the regulatory functions.

1.1.1 Emergence of large-scale non-grid electrification in South Africa

The next phase of the electrification programme involved the connection of more remote areas requiring carefully thought-out planning in order to reduce the average connection cost. In this light, solar photovoltaic (PV) non-grid was considered to be an attractive economic option for less dense rural settlements, and the government thus started a process of integrating both grid and non-grid technologies for electrification based on cost considerations (Kotzé, 2000).

For a variety of reasons, there had been little formalised delivery of non-grid electricity services to rural communities as part of the national electrification programme (Banks et al 2000). Although an estimated 40 000 to 60 000 solar home systems (SHS) have been installed on a commercial basis, without government involvement or subsidies, this fairly developed private market was undermined substantially when Eskom embarked on its 'Electricity for All' campaign (Cowan et al, 1996). Morris (1992) states that, 'since the start of the national electrification programme, sales of domestic solar PV systems to rural communities have dropped significantly'. The campaign led to widespread expectations by rural communities that they would receive grid electricity in the near future.

Various organisations have been grappling with this issue for several years, and a number of different non-grid electricity supply models have been tentatively explored (Banks & Karottki, 2000). In 1995 the DME established the company Renewable Energy for South Africa (REFSA) Pty (Ltd) to finance and oversee credit-based large scale delivery of non-grid systems in rural areas (Banks & Karottki, 2000).The credit base was because of the constraints to the direct retailing of non-grid systems to end-users. REFSA was eventually disbanded. According to the DME the cost of creating and maintaining the necessary infrastructure for delivering such a service in deep rural areas rendered the process uneconomical (Kotzé, 1999). The DME concluded that the difficulties associated with planning, funding, maintenance and affordability pertaining to large-scale dissemination of non-grid technologies could be overcome through a privately-owned utility delivery model. After several consultations with various stakeholders, in the beginning of 1999, the Department of Minerals and Energy (DME) adopted the concessionaire model as the delivery mechanism for the non-grid electricity service to poorer communities. This approach involves the allocation of designated remote areas to approved utilities to provide non-grid electricity services for an agreed fee to be paid by the customer – this is largely referred to as *fee-for-service*.

1.1.2 Rationale for the non-grid electrification programme

The main rationale for the utility fee-for-service model was based on the reasoning that (Kotzé, 1999):

? It would speed up the process of achieving universal access to electricity envisioned in the Energy White Paper since non-grid electricity service had become increasingly cost-effective in remote areas.

? It could attract larger, better organised private companies with their own sources of financing.

? It would facilitate and rationalise electrification planning, funding and subsidisation at national level.

? It has the potential to reduce equipment costs (through volume discounts), transaction costs, and operation and maintenance costs (through economies of scale).

? It ensures service to the customer over a long period of time (e.g., 20 years).

? The utility would own the hardware as assets, which should facilitate the raising of capital on the money markets, while the strong financial and maintenance controls characteristic of the private sector should facilitate the channelling of international development funding.

? It was expected that the service providers would adopt a delivery model that promotes a range of fuels such as gas or paraffin, in addition to SHS or mini-grid systems. This energisation model has been motivated by the realisation that electricity often does not meet all the energy needs of rural people, who, after electrification, tend to continue to rely on multiple fuels.

? Most rural dwellers that have access to grid electricity are usually not able to afford higher consumption of electricity and therefore they tend to use it mainly for services that can be equally provided by SHS. The service level that is subsidised under the non-grid electrification programme was set at 50Wp.

The main disadvantage envisaged in the programme possibly lay in the fact that the hardware is installed at the end-users' premises, under his/her control but not under his/her ownership and responsibility, which therefore makes it prone to vandalism, neglect and misuse. It was expected that these may, however, be overcome through professional customer care.

1.2 Government non-grid electrification programme

Solar electrification of rural households on a larger scale in South Africa began in earnest during early 1999, when the then President, Nelson Mandela, launched a Shell Solar South Africa -Eskom Joint Venture project in the Eastern Cape (Banks & Karottki 2000: 2). This Joint Venture (Eskom-Shell) between Eskom and Shell Solar South Africa (50%: 50% shares) had been announced earlier on in October 1998. It initially undertook to electrify some 50 000 households with solar home systems (SHS) over the next 5 years (Kotzé, 1999). The Eskom-Shell joint venture had installed about 6000 SHSs in the northern part of former Transkei (currently part of the Eastern Cape Province) by March 2000, and during the next three years, the project intended to supply more than 50 000 households with 50Wp PV systems. These solar home systems are capable of powering small black and white television sets, radios and 3 to 4 lights (Banks & Karottki, 2000).

As observed by Wamukonya & Lithole (2000), the launch of this project was highly publicised and politicised, which might have influenced the schedule of the government's non-grid electrification programme. This triggered wide interest from the PV industry which also spurred the DME to advertise a Call for Proposals in the Sunday press in January 1999 inviting the private sector to submit proposals for non-grid electrification projects. Out of a total of 28 proposals received from different consortia, 6 were approved by a task team of the National Electrification Co-ordinating Committee (NECC) in addition to the Eskom-Shell Joint Venture.

Five of the original seven consortia selected to participate in the programme are still involved, but two have withdrawn for various reasons and one is barely operational. Each of these consortia has been allocated an area of operation. The geographic areas allocated to these consortia are broadly defined and include areas with access to the electricity grid. The non-grid service providers were to target small pockets within these broader areas, which are to be identified on an annual basis in consultation with the appropriate grid utility and service authority, although problems with identifying these permission areas have recently been highlighted as a problem by the service providers. A sixth service provider will operate in the Northern Province.

1.2.1 The nature of the utility route taken

Internationally, there is growing interest in the 'energy-service-company' (ESCO) model for the delivery of solar home systems (SHS). This utility service provision (or ESCO) model is based on a fee-for-service approach, which guarantees maintenance of the systems in the area of operation of a particular non-grid utility. This means that the ESCO owns the system, charges the household or end-user a monthly service fee, and is responsible for maintenance and servicing of the solar home system. The ESCO may be a monopoly concession regulated by the government to serve specific geographic regions (as planned in Argentina, Benin, and Togo), or it may operate competitively without any explicit monopoly status (as in the Dominican Republic). Combinations of these two forms of ESCO start with monopoly concessions and progressively open up markets to competition after some years (as in the Cape Verde) (Martinot et al, 2000). The concession approach to the provision of off-grid electricity services is a recent development internationally and there is limited international experience to draw from (ECON et al, 1999).

Since the process of implementing this model started in South Africa, negotiations between different role players have led to significant changes in the structure of the programme and the roles of different parties. The programme no longer entails the establishment of monopoly concessions, since the term "concession" in South Africa presents a legal connotation different from what the non-grid electrification programme is intended for. The utilities would have exclusive rights to government subsidies to cover substantial portion of the capital costs for 5 years, and the fee-for-service agreement will last for 20 years. Furthermore, the non-grid service providers are expected to improve access to a range of fuels such as gas and paraffin, in addition to Solar Home Systems (SHS) and mini-grid systems. A detailed understanding of the institutional arrangements has been documented by Afrane-Okese & Thom (2001).

1.2.2 Institutional and contractual arrangements and the delivery of subsidies

The institutional arrangements generally agreed upon to implement the programme during the period of this study were as follows.

It was decided that the selected private consortia will be established as non-grid service providers in selected rural areas in a contractual arrangement with the licensed electricity utilities in these areas – in most cases this would be the national utility Eskom, while the Durban Metropolitan Council may play a role in certain areas around the Durban Metropole. For this purpose, the distribution licenses held by Eskom and the Durban Metropolitan Council in the selected off-grid areas would be amended by the NER to include off-grid electrification.

It was also arranged that Eskom would be appointed an Agent of government (the Department of Minerals and Energy) to enter into and administer the non-grid energy service contracts with the selected non-grid service providers. Eskom would be responsible, among other things, for demarcating the non-grid areas, monitoring the performance of the non-grid service providers, and reporting to the DME and NER on progress in the non-grid programme.

Initially, the role of the National Electricity Regulator (NER) was to establish a regulatory framework for the non-grid programme, and also be responsible for regulating prices, technical and customer service standards, and the management of disputes.

Subsidies for the capital costs of the non-grid electrification were to be provided through the national electrification fund, which was administered by the DME. The selected non-grid service providers have exclusive rights to receiving subsidies for non-grid electrification in particular geographic areas for a period of five years, although the non-grid service contracts are to remain in force for a period of 20 years.

The non-grid service providers were expected to improve access to a range of fuels such as gas or paraffin, in addition to SHS and mini-grid systems.

At the time when this case study was well under way, the regulatory, institutional and contractual arrangements for the non-grid programme implementation had still not been completed. The Eskom-Shell JV, which had been operating without the promised subsidies, was the only non-grid service provider that was operational. Apparently, an auditing report on the Eskom-Shell Joint Venture did not provide a convincing success story for the Eskom Management to agree to act as government's agent in the concessionaire contract. This resulted in long delays in the signing of the contract with the non-grid service providers. It even came to embarrassing situations where overseas partners of the service providers were threatening to pull out of the investments if the issues delaying the signing of the contract were not ironed out quickly. The National Electricity Regulator (NER) in consultation with the Department of Minerals and Energy (DME) jumped to the occasion to sign an interim contract with the service providers in early 2000 and guaranteed the subsidies for the capital costs of the solar home systems (SHS) installation in order to kick-start the implementation. The subsidy for each 50 Wp SHS installation was fixed at R3500 and this was guaranteed for the first period of eighteen months till conclusive agreements have been made between the actors in the contract. During the past two years, the issue of subsidies has become explosive. In relation to operational subsidies for which the government had suggested a R40 per month subsidy for the service fee, the situation is even more complex. The payment of this particular subsidy must be paid through local government (Government Gazette, 04 July 2003).

1.3 Eskom-Shell Joint Venture operational system

1.3.1 Service area

The north-eastern Transkei area of the Eastern Cape where the Eskom-Shell JV chose to implement the first stage of its solar home systems project is one of the most deprived areas in the country with rich political history. The area is also one of the most difficult geographical terrains in South Africa with poor and impassable roads, high mountain ranges, valleys, cliffs and gorges making it difficult to respond to system maintenance calls within a reasonable time. Although the area has stunning landscapes setting the scene for tourist attraction towards the traditional homestead settlements, as one of the homelands during the apartheid era, the land is mostly barren leading to severe unemployment and poverty in the area. The area of operation includes the rural settlements of the towns of Bizana, Mount Ayliff, Flagstaff, Tabankulu, Mount Frere, Matatiele and Mount Fletcher (see Map on page xi). The DME later approved the inclusion of some parts of southern KwaZulu-Natal (KZN) Province in the service area.

1.3.2 Service provision

The non-grid electricity service delivered by the Eskom-Shell is packaged in a SHS called the Power House with a rated power from the PV module of 50Wp. It provides power for 3 inside lights, 1 outside light, 3 plug-and-play points for a radio, a black-and-white television and smaller DC appliances like a cash till. Customers paid R110 (at the time of the first survey in 2001) for the installation of this system and a cellular phone charger accessory was offered for an extra R20. The Power House charge/discharge regulator and the battery are enclosed in a casing jointly called "tower". There is a smart switch in both the solar panel and the battery to protect the system against theft and tampering. The system also has a card reader that disconnects the system from supplying power when there is not enough credit on the inserted prepayment card. The battery is sealed to avoid any tampering by the user. CONLOG, an electronics hardware and software company in Durban, supplies the towers and the systems are delivered via Shell Solar South Africa in Durban. The batteries are supplied locally by First National Battery based in East London and the solar panels are imported from Amsterdam, The Netherlands.

Each SHS customer is expected to purchase a prepayment card or token for R58[3] from an outlet to last at least 30 days. In the event that the customer is unable to purchase a prepayment card after this period, the smart switch turns the system off, disallowing the customer access to power. Not only is the customer denied access to the use of power from the system when unable to purchase a new card, the system also records all the days when the customer did not use the system as negative credit against the customer. Thus, when a new card is purchased by a customer who could not use the system for a number of days due to non-payment, the customer does not have access to the full 30-day credit on the card but rather the remainder when the negative credit is deducted. It is like paying for a hotel room when you are away. Since some people have some experience of prepayment systems like a cell phone and grid electricity which do not force you to pay when you can't afford it, this new concept of "rented service" has brought a a great deal of misunderstanding amongst customers.. There have also been reports of customers who stop their monthly service payments at some point or other because their systems were not functioning well. In such a case, Eskom-Shell gives the customer a card that has credits sufficient to cover the number of days that were lost due to the faulty system.

The services provided by Eskom-Shell to their customers include installation of the SHS, ensuring that the system is in good working order, ensuring that customer' complaints are looked into replacement of lights, extension of wires for lights, connecting appliances to the system, maintaining the water level in the battery, cleaning the panels and relocating the panels when requested by the customers. Most of these services are included in the monthly service fee that is paid by customers except in the case when customers are responsible for the malfunctioning of the system or in the case of relocation when they are asked to pay a small fee.

[3] The monthly service fee which is paid in exchange for a prepayment card has been increased to R58 from R52 in 2002.

1.3.3 Service delivery and management

An impressive thing about the operation of Eskom-Shell is that most of the operational staff was recruited from the community based on recommendations of community leaders. Thus, Eskom-Shell has initiated some job creation and skills building opportunities in this deprived area, however limited this may be considered to be by communities interviewed. The communities acknowledged that the ESCO's have been able to create some employment and training opportunities in their areas of operation.

The installation phase of the first stage of the project seems to have been rushed due to political promises which needed to be fulfilled and many pressures for service delivery to the deprived people. During the installation phase, local entrepreneurs acted as Sales Managers for the 5 Rural Energy Service Companies (RESCOs) established in 5 towns within the service area. Thus there was less company control of the RESCOs. A selected number of communities were requested to appropriate shops to act as SHS outlets under the RESCOs where sales, purchase of tokens and maintenance services were coordinated.

Although it was a positive thing employing community people to be in such a project, there were no criteria in place for the community in the selection of sales and field staff during the installation phase. The Sales Managers were not adequately accountable. This resulted in a lot of fraudulent deals, insufficient customer care and customer dissatisfaction. Remuneration was based on the number of systems "sold" and led to unfulfilled promises to customers regarding the capabilities of the technology. People were under the impression that they would be able to cook, use their colour TV's and refrigerators. Cases were reported of households having more than one system in the hope of increasing their "power" for cooking purposes.

The company therefore took control of the RESCO offices and appointed an Area Manager and a Clerk for each of the 5 inland rural areas namely, Bizana, Tabankulu, Flagstaff, Mount Ayliff and Mount Fletcher (these are all small towns inland as depicted on the map on page xi). Their appointment was based on a set of criteria specified by the company. Each area is divided into zones and there are 45 zones altogether with 6-9 zones in one area. Each zone has about 3 to 5 outlets, which are mainly shops (mostly spazas) where the service prepayment cards are sold and maintenance problems are reported. Apart from these, there are also 2 super-outlets in Mount Frere and Matatiele, which coordinate the operations of outlets dealing with more than 200 SHS each. Altogether, there are about 130 outlets servicing the whole area.

Out of the 240 installers contracted during the installation phase, 45 were selected and trained as technical inspectors to service and maintain the systems in each zone and also to check on reasons why customers may not be buying prepayment cards. The Area Managers have the responsibility of visiting the zones once a week, delivering spares such as batteries to the inspector in each zone and overseeing that all maintenance and service problems are dealt with. Their work involves a lot of driving on bad and winding roads consuming a lot of fuel. The company has leased cars to them, the payment of which is deducted from their salary. However, they are paid for their fuel consumption within reasonable limits. The operations of the Area Managers are closely monitored and coordinated by an Operations Manager who travels extensively in all the areas of operation and reports to the General Manager at the company's headquarters in Port Shepstone at the coast. Each of the Area Clerks deals with the keeping of records of prepayment token sales, maintenance and service complaints and their solutions, equipment delivery and taking in application forms from potential customers. The inspectors work closely with the Clerks in order to deal with maintenance and service problems in an orderly and prompt manner. Although the inspectors are still monthly contract workers, they are in a more formal relationship with the company now.

Due to the technical and sensitive nature of the security protection system, more skilled and trustworthy inspectors were appointed as senior inspectors to handle more sophisticated problems requiring sensitive decoding information. Each of the 5 RESCOs, as well as each of the 2 super-outlets, has a senior inspector who is currently hired on 30-day contract, however, the company is intending to bring them in soon as permanent staff. These senior inspectors have been given special training to equip them to deal with high-level complex maintenance and service problems. The main problem facing the senior and ordinary inspectors is lack of transport, as they have to rely on public transport, which is not frequent sufficiently for them to respond to maintenance calls in good time. They often have to resort to walking to sort out maintenance problems and that causes more delays in service delivery.

1.4 Study objectives: support for and tracking the government non-grid programme

This report is one of three reporting results from each of the non-grid concession areas: the Eastern Cape, KwaZulu Natal and Limpopo. The three form part of a project initially funded by the Shell Foundation[4] for supporting and tracking the impacts of the South African government's non-grid concession programme over a period of three years. The ambitious development objective of this project is to support the delivery of sustainable energy services that will contribute towards improved environmental, economic and social status of the rural population in South Africa. The immediate objective of is to ensure that the responsible public and private agencies make informed decisions to improve non-grid energy service delivery as a component of integrated rural development. Due to the limited global and local experience in this delivery model, this project seeks to provide monitoring of the programme, and support to stakeholders where required, in order to establish appropriate approaches which will ensure that the goal and objectives of the programme – and in particular the needs of rural communities – are met. In addition, the lessons learned form the South African experience will be of interest beyond South African borders. The main issues addressed in this research are:

1. The regulatory, institutional and contractual arrangements for implementing the non-grid concessions programme in South Africa
2. The capacity in South Africa to undertake monitoring of the non-grid programme, including the capacity of the National Electricity Regulator.
3. Energy use patterns, socio-economic conditions, and the availability of energy services in three non-grid concession areas.
4. Users responses to the non-grid services provided as measured over time, the extent to which energy needs are met by off-grid systems, and the socio-economic impacts of the programme.
5. The effectiveness of service delivery approaches and mechanisms employed by service providers/concessionaires participating in the non-grid concessions programme.
6. International experience in non-grid electricity service provision as compared with the South African experience.
7. The effectiveness of the regulatory, institutional and contractual arrangements to implement the non-grid concessions programme in South Africa.

Issues 3 and 4 are dealt with in this report. The report on issue 6 is available at the Energy Research Centre.

1.5 Research methodology selected study areas and survey design

The first round of field studies, including the household surveys, were undertaken in three of the five non-grid service provision areas. These three areas are located in the Eastern Cape (north-eastern portion of the former Transkei), northern KwaZulu-Natal and the Limpopo Province. This report assesses the preliminary impacts of the non-grid electrification in rural Eastern Cape. A second phase of field studies including the re-visiting of households was be undertaken at the end of 2003 and will be published as a supplement to this report.

Fieldwork consisted first, (in June 2001) of a series of interviews with service providers and their staff at various levels of the companies. The accounts of these interviews have been documented elsewhere (Afrane-Okese, 2002). In addition, informal interviews took place with community representatives in areas where non-grid electrification had taken place. Finally, in each of the non-grid service areas, a substantial number of households were interviewed.

[4] The Shell Foundation funded this research until they withdrew from the project in September 2003, leaving the Energy Research Centre the responsibility of carrying the research through to its conclusion.

1.5.1 Selection of household samples

It was initially intended that the research design of the household surveys would follow the lines of a classic 'before and after' study. The intention was that those households who had applied for and who had paid for a SHS, but not yet received it, would be interviewed and these would form a baseline study. The same households would be interviewed again after they had had the system for at least one year. However, the delays in the program implementation did not allow for any significant accumulation of SHS applications before service providers had started installations of the systems. For the Eskom-Shell Joint Venture, the 6000 systems were installed before the research project began in earnest. With this situation, the only alternative was to design the survey to incorporate two control panels. Small samples of households who had never had electricity, living in the neighbourhood of households with solar homes were included as proxy for the baseline data collection. Small samples of grid-electrified households in areas adjacent to Flagstaff and Tabankulu were also included in the survey to provide a basis for comparison between services provided by grid- and non grid electrification (Afrane-Okese, 2002).

1.5.2 Interviewing

Interviews were 'face-to-face', that is administered by trained interviewers, as opposed to 'self administered' questionnaires and they were conducted in the language of the household.

There were certain weaknesses in the design of the questionnaire. Some questions would have benefited from more careful pre-tests. In analysing the data, it became clear that some questions had not been understood by the respondents or the interviewers.

The training of interviewers is an essential part of obtaining good data. Unfortunately, since the interviewers had to be chosen from members of the local communities, sometimes according to lists given by the chief, not as much time as would have been necessary could be devoted to their training[5]. A typical example of lack of expertise on the part of some interviewers was a one phrase 'response' to "open-ended" questions where the interviewer was required to write out verbatim the replies of the respondent.

The questionnaires gathered information on a range of subjects relating to the impact of the solar system on the household. These items included: the household's application for a solar home system, their initial expectations of what a solar home system would provide them with, the experiences of using a SHS and problems that they may have had with the components of the system and the impact of solar lighting and access to media on the household. A further series of questions dealt with the availability and use of other fuels (such as candles, paraffin, gas, fuel wood, batteries) and any changes in fuel-use that had occurred since the household had obtained a SHS. A final group of questions obtained demographic information such as, education, employment and income data for each household.

For certain questions it was difficult to obtain reliable data. These are the notoriously "dubious" questions that relate to household income and expenditure. There is in such questions not only a reluctance to answer, especially to a stranger (the interviewer) who is writing it all down, but also a difficulty for households to express earnings in monthly figures except where the wage or salary is regular or the source comes from a pension. For fuel use, many households found it equally difficult to state how much of a fuel was used in a month or at what the cost. Households living in or on the borders of poverty manage almost by instinct to budget their limited resources but they may not be able to describe to an outsider how they achieve this. Here, as in all social research, the quality of the data depends to a very large extent on the training of interviewers.

[5] The need for better and more lengthy training of interviewers was resolved for the follow-up surveys with the same households which took place at the end of 2003

PART 2

2. Socio-economic context of rural solar electrification in the Eastern Cape

The Eastern Cape with a population of seven million is one of the poorest provinces in South Africa. In terms of average annual household income, the province shares with Limpopo the lowest rates of average income. Households in the Eastern Cape have no more than 1/3 of the average annual income of households in Gauteng. The Eastern Cape is a province of great contrasts. The lush forests of the Wild coast and its lengthy coast-line contrast sharply with the dry desolate Great Karoo of the interior. There are fertile regions known for their apple harvests and rich agricultural lands produce crops as varied as pineapples, coffee and tea. The mountainous regions are renowned as a tourist attraction. But in other areas, sustaining a livelihood is extremely difficult. The former Transkei region where this longitudinal study took place, is dependent on cattle, maize and sorghum farming for the income of the area. Other than farming and some work in local towns, there is little formal employment.

2.1 Samples and sub-samples of SHS-users, grid-users and households without electricity

The samples of households for this study were selected from six rural areas, namely, Mt. Fletcher, Matatiele, Mt. Ayliff, Flagstaff, Tabankulu and Bizana shown below in the map of the North-Eastern region of the Eastern Cape. The headquarters of the service provider is in Port Shepstone. The numbers of SHSs that had been installed by Eskom-Shell varied considerably from area to area (Mohlakoana, (2001).

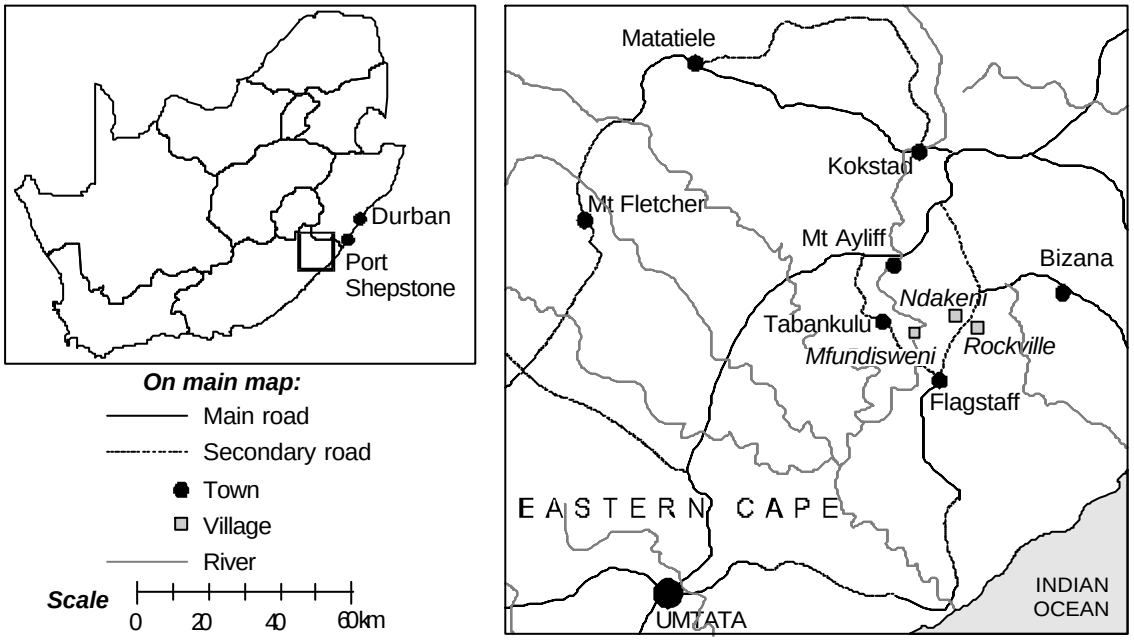


Figure 1: Map of the study areas in the Eastern Cape

The number of households interviewed in each area was, as far as was possible, in proportion to the number of SHSs installed to date in that area. A total of 891 rural households from the three provinces were interviewed in the first phase of the study. Due to the larger number of SHS installations that had been done by Eskom-Shell, proportionally more households (348) were interviewed in the Eastern Cape than in the two other service areas. 262 households were interviewed in KwaZulu-Natal and 281 in the Limpopo province.

Table 2.1: Number of households interviewed in different communities in the Eastern Cape

Community	*Non-grid solar*	*Grid-electrified*	*Non-electrified*	*Total*
Bizana	49		50	99
Mt.Ayliff	46		15	61
Tabankulu	23	26		49
Flagstaff	50	25		75
Matatiele	31			31
Mt.Fletcher	33			33
Total	***232***	***51***	***65***	***348***

Most of the areas are composed of several villages. Bizana for instance, consists of seven villages. There were quite wide differences in the socio economic conditions of households both within and between the six districts. (The particular differences between districts have been described in detail in (Mohlakoana, 2003)

Moreover, there are many variables which determine the difference between the three groups of households (solar users, grid-users and non electrified households) of which geographic location is just one. Household size and composition, income, education, gender, employment status, the structure of the homestead and the migration of household members away from the rural area are others. In the sections that follow, these factors are explored in as far as they differentiate the three subgroups in the sample.

2.2 Income levels of different sub-samples, sizes of households and per capita income

The total income of each household was ascertained by adding incomes for each member and for each of a variety of sources of income; regular wages and salaries, informal earnings from part-time work, piece jobs or informal selling, from self employment, from state grants and pensions and from contributions made by members living away from home. From this sum of income was deducted the amount of money sent by the household to support someone not counted in the list of household members. Obtaining information on income is notoriously difficult. The margins of error are large. Much depends on the training and skills of the interviewers.

Nevertheless, the data analysed[6] here provide some indication of the differences in income between the three sub samples in the study. Taking the survey as a whole, there are substantial differences in the total income (from all sources) declared by households: from as little as R100 per household for six of the households interviewed, to more than R R17 000 for one household with a solar system. This is indeed one indication of the heterogeneity of rural populations.

Comparison of the mean income for each of the three sub-samples clearly shows that they differ quite substantially in terms of income.

Table 2.2: Mean income according to sub-samples

Sub-sample	*Minimum*	*Maximum*	*Mean*	*Standard deviation*
SHS-users	R100	R17 040	R2307	R2257
Grid-users	R100	R9000	R1860	R2060
Non-electrified households	R100	R5000	R819	R193

Measuring and comparing incomes, requires taking differences in household sizes into account. The number of occupants is the crucial variable in determining the income available for needs of each member and the quality of life of the family. Table 2.3 below provides information about the variation in household sizes.

6 "Missing" data was handled by providing a figure as close as possible to the median value observed for the particular sub-sample.

Table 2.3: **Household size according to sub-samples**

Sub-sample	*Minimum*	*Maximum*	*Mean*	*Standard deviation*
SHS-users	1	11	4.9	2.11
Grid-users	1	8	4.9	1.78
Non-electrified households	1	12	6.1	2.43

Households that have no electricity are more likely to be those with the largest number of members. Referring again to Table 2.2, these households also have the lowest average household monthly income. The comparison of the mean per capita income confirms this.

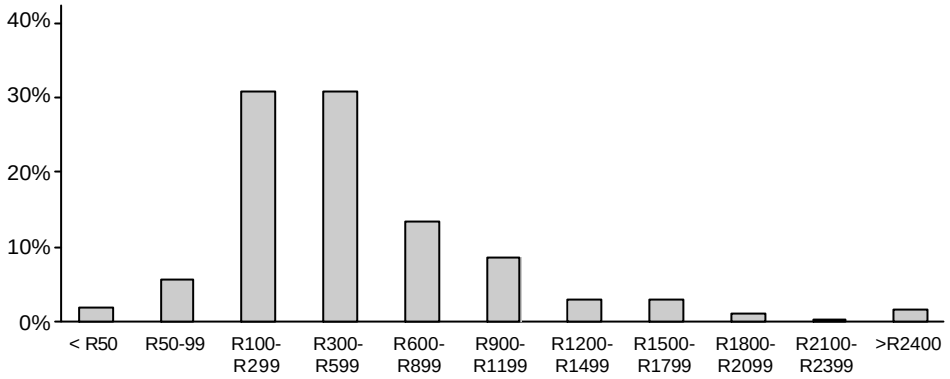


Figure 2.1: Grouped per capita monthly income of SHS-users

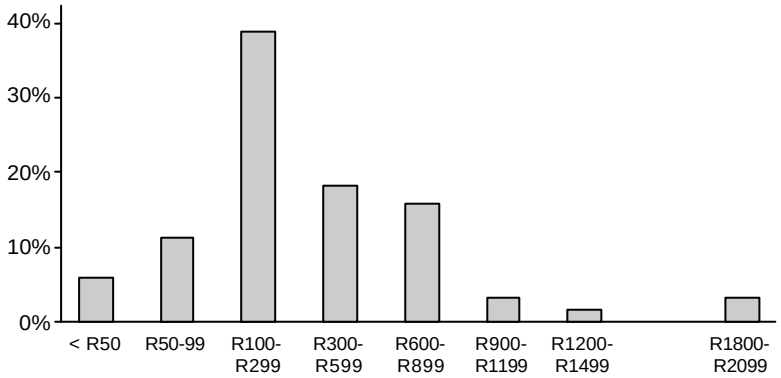


Figure 2.2: Grouped per capita monthly income of grid-users

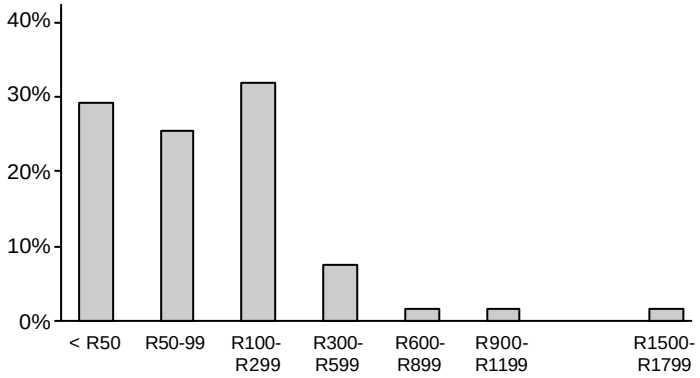


Figure 2.3: Grouped per capita monthly income of non-electrified households

Figures 2.1 to 2.3 show clearly that SHS-users fall predominantly into the 3rd and 4th categories of per capita monthly income (between R100 and R599 per person). Few households fall into category 1 (less than R50 per month per person) or the category 2, (between R50 and R99 per month per person).

Some households fall into category 11 with more than R2 400 per person per month. The largest number of grid-users falls in category 3, between R100 and R299 per person per month with no households falling into the categories higher than 9 (R1800-R2099 per person per month).

Non-electrified households fall almost exclusively into the lowest categories 1 to 3.

Table 2.4: Mean per capita income according to sub-samples

Sub-sample	*Minimum*	*Maximum*	*Mean*	*Standard deviation*
SHS-users	R17	R3408	R542	R499
Grid-users	R40	R1885	R401	R417
Non-electrified households	R14	R1667	R169	R260

It is clear from the above figures and tables that incomes are considerably higher in SHS households than amongst households who have grid electricity and substantially higher than households who have neither type of electricity. The difference between the mean per capita income of R542 for SHS-users and that of R169 for non-electrified households is significant. An average of R170 per month per capita is just over R5 per person per day.

It is however, possible that the sample selection explains some of this bias. To be eligible for a SHS, households had to prove that they had regular incomes. Since the non-electrified household lived in the same areas, it is likely that they simply did not qualify to have a SHS. These same households would be excluded from accessing the grid since they would not be able to afford the grid connection fee.

2.3 Sources of income

Comparing the various sources of income for each of the three sub-samples provides further insight into the differences between them.

First, in terms of households that have at least one person earning a regular wage, solar home system users are more likely to have some member with regular employment as the Table 2.5 below shows.

Table 2.5: Sources of income according to sub-samples

Income sources	*SHS-users N=232*	*Grid-users N=51*	*Non-electrified households N=65*
Regular earnings salary/wages	64%	47%	51%
Pensions and state grants	38%	47.1%	39%
Own business	18%	6%	0%
Piece jobs	7%	16%	16%
Informal selling	12%	4%	8%
Note: Percentages in this table do not total 100%. 64% represents the number of positive replies to the question: "Does any member of the household receive a regular wage or salary, a state grant, etc.?"			

Though non-electrified households do have members earning a regular wage, the previous tables suggest that this wage is on average lower than in the case of SHS-users and there are a larger number of household members between which this source of income is divided.

State grants[7] and pensions make up more than a third of household incomes for all sub-samples.

[7] There was probably an underreporting of child support grants. It is true that many households are excluded from obtaining child support grants due to the absence of birth certificates, but interviewers tended not to insist on this information.

Clearly, SHS-users are far more likely to have a member with their own business than grid-users. Significantly, no members of households without electricity have their own business. Both grid-users and non-electrified households are more likely to have members earning from piece-work and part-time jobs while SHS-users are more likely to have members who are earning from informal selling.

A correlation between income and educational levels of household members is to be expected.

The following Table summarise the main differences between sub-samples according to the highest level of education attained by the "head" of the households.

It is not necessary here to enter into the debate about what constitutes a household "head" although this is an important questioning of a concept so frequently used in social research. The current study used the classical definition as referring to the person who takes the most important decisions within the family and is usually the bread-winner.

Table 2.6: Highest education level of household head according to sub-samples

Highest education level of household head	*SHS-users N=229*	*Grid-users N=51*	*Non-electrified households N=63*
No schooling	24%	12%	37%
Primary school	14%	20%	33%
Secondary school	26%	22%	22%
Matric	13%	39%	5%
Post matric	24%	8%	3%

In remote rural areas it is not surprising to find quite a large number of adults with no schooling. In the table above that refers to household heads, the proportions of heads without schooling are relatively high for each sub-sample but particularly high for non- electrified households.

SHS-users are far more likely to have post-matric qualifications as the table above shows.

Table 2.7: Age categories of head of households for sub-samples

Age categories	*SHS-users*	*Grid-users*	*Non-electrified households*
18-29	2%		11%
30-44	35%	37%	31%
45-59	31%	28%	40%
60+	32%	39%	19%

There are relatively more young household heads amongst non-electrified households. Compared with SHS-users and households with grid electricity, there are relatively few heads who are 60 years or older. A plausible explanation for these differences is not immediately obvious, except perhaps a predominance within non-electrified households of "recomposed households" with younger members who are taking over the running the home.

2.4 Gender of household heads

The gender of the head of the household is relevant largely because research has shown that female - headed households are generally poorer than their male counterparts.

In two of the sub-samples, grid-users and non-electrified households, the percentage male-headed to female-headed households is quite similar. (49% male and 51% female). Curiously, the proportions are reversed for SHS-users where 60% of households are headed by a male and 40% by a female. It is probable that the selection of applicants to receive a SHS gave preference to male-headed households.

2.5 Type and size of homesteads

The most common type of homestead found among households surveyed is a mixture of traditional huts and other buildings as the table below shows.

Table 2.8: Type of homestead

Type of homestead	*SHS-users*	*Grid-users*	*Non-electrified*
Traditional homestead	9%	39%	23%
Single house with multiple rooms	20%	20%	23%
Mixture of traditional huts and other buildings	69%	39%	52%
Informal house	2%	2%	2%

SHS-users predominantly live in a mixture of traditional huts and other buildings. Their homesteads are larger than those of the other two sub-samples. The mean number of rooms is 6.4 compared with 5.2 in the case of grid-users and 4.8 in the case of non-electrified households. These differences are important in terms of the density of occupation and probably also the quality of life, the comfort and the quality of in door air. The use of cooking and lighting fuels other than electricity by non-electrified households compounds the high density of occupation.

If the mean number of rooms is 6.4 and the households eligible for the non-grid programme only receive 3 inside lights, the other rooms remain without electricity. This means that the solar-electrified households still use a considerable amount of either candles or paraffin to satisfy their lighting needs for the rooms that do not have solar lights.

2.6 Employment status of heads of households

Table 2.9: Employment status of household head according to sub-samples

Employment status	*SHS-users*	*Grid-users*	*Non-electrified households*
Employed	40%	22%	23%
Unemployed	37%	39%	43%
Self-employed	11%	8%	9%
Housewife	0.4%		12%
Pensioner	3%	31%	12%
Disability pension	7%		

From this table the selection process of solar home applicants is clear. The household head in households with SHS is twice as likely to be employed as for the other two sub-samples. Unemployed household heads account more than a third of households in both the SHS-users and grid user sub-samples but reach 43% of household heads of non-electrified households. The fact that 31% of heads of grid households are pensioners is explained by the fact that 39% are 60 years or older.

2.7 Migration: Household members living away from home

Migration from rural areas to towns and cities has been well documented, but from a household's perspective, less is known about how many members live away, whether they remain dependent on household resources or are contributing to the household budget whether in kind in the form of food, electrical appliances or in money. For the purpose of this study, there were two motives in collecting data on migration. The first was to arrive at the best estimate of all sources of household income. The second was to explore the possible influences that absent household members could have had on the choice of a SHS and in the households experience and knowledge of grid electricity.

The following table is a summary of the numbers of absent members and their status as contributors or dependents on household resources.

Table 2.10: Absent household members

Absent members	*SHS-users*	*Grid-users*	*Non-electric households*
Household heads absent	14%	9%	3%
Percentage of households with **no** members living elsewhere	25%	37%	37%
Someone else contributing to household	12%	24%	5%
Supporting absent members (Child, Parent)	28%	6%	6%

The head of households in which SHS have been installed is more likely to be absent than in the case of non-electrified households where many household heads are unemployed and at home. Having any members move out of the household appears to be less common amongst the non-electrified households surveyed than for SHS-users.

Grid user households are more likely to be receiving contributions from someone outside the household than are SHS-users. Few of the non-electrified households receive any contributions from outside, which no doubt further depresses available household income. (Table 2.5)

Supporting an absent child or a parent is a further "burden" on households. Table 2.10 above indicates the higher percentage of SHS-users supporting an absent child or parent.

3. Main end-uses of various fuel/energy sources and proportion of income devoted to energy

The ownership and use of electrical appliances by both SHS-users and grid-users is taken up in greater detail in Section 7. The monthly expenditure of households on fuels other than electricity is presented in Section 8. Here, it is useful to summarize the main findings related to ownership of solar and electrical appliances before reviewing the main types of fuels used for different purposes by the household.

A similar number about 1/5 of SHS-users and grid-users have only one appliance. The percentage of households owning 2, 3 and 4 solar or electrical appliances is given in the Table below. Among grid-users, almost one third have 4 electrical appliances.

3.1 Ownership and use of electrical appliances: SHS-users and grid-users

Table 3.1: Ownership of solar or electrical appliances.

*Number or electrical appliances**	*SHS-users*	*Grid-users*
1	20%	23%
2	40%	23%
3	29%	20%
4	11%	33%
* This includes only appliances which can be used with solar. It excludes the appliances SHS users own but cannot use		

The appliances used by SHS-users are predominantly media appliances: radio, hifi, black and white television and cell-phone chargers.

Two questions about main fuels were asked of respondents. What was the main fuel used for each specific end-use (lighting, cooking, water-heating etc); and for each end-use, the fuel they would like to switch to given the opportunity**.**

Table 3.2 Main fuels used for specific purposes and fuels users would like to switch to

	Fuels SHS-users presently use	*Fuels SHS-users would like to switch to*	*Fuels grid-users presently use*	*Fuels grid-users would like to switch to*	*Fuels non-electrified users presently use*	*Fuels non-elec users would like to switch to*
Lighting:						
Electricity		99%	100%	100%		70%
Solar	97%	0.9%				30%
Candles	1%				80%	
Paraffin	1%				19%	
Cooking:						
Electricity		93%	20%	96%		75%
Solar		1%				25%
Paraffin	59%		38%		53%	
Gas	27%	2%	14%		3.%	
Wood	12%	1%	28%	4%	44%	
Water heating						
Electricity		94%	10%	96%		79%
Solar		3%				21%
Paraffin	63%	1%	60%	2%	55%	
Gas	15%		2%		4%	
Wood	22%		28%	2%	42%	
Space heating						
Electricity		93%	8%	84%		79%
Solar		2%				21%
Paraffin	54%	4%	24%		24%	
Gas	2%				3%	
Wood	40%	1%	68%	16%	73%	
Refrigerating						
Electricity	0.4%*	96%	92%	100%		100% (3 cases)
Solar		3%				
Paraffin			(1 case)			
Gas	82%				100% (3 cases only)	
Car battery		1%				
Generator		4%				
Wood						
Ironing						
Electricity		96%	44%	100%		81%
Solar		3%				19%
Paraffin	72%		56%		69%	
Gas	20%				3%	
Wood	7%**				28%	
TV						
Electricity		97%	96%	100%		72%

Solar	83%	3%				28%
Car battery	14%		4%		96%	
Generator	3%				4%	
Radio						
Electricity		95%	76%	100%		83%
Solar	79%	5%				17%
Car battery	5%				6%	
Dry-cell battery	17%	0.5%	24%		94%	

* One household uses a generator to run the fridge

**One household uses coal for ironing

3.1.1 Lighting: Fuels presently used and fuels the household would like to use

3% of SHS-users did *not* use solar as their main energy source for lighting. Three households were using paraffin for lighting at the time of the survey, three were using candles and one household was using a generator. One of these households had at the time of the survey been without a functioning SHS for six months.

Most households had to supplement the solar home system with candles or paraffin lights in rooms not lit with solar lights. 100% of grid electricity users were using electricity for lighting. 80% of non-electrified households use candles as their main fuel for lighting and a further 19% rely on paraffin.

When households were asked what lighting fuel they would like to switch to "given the opportunity", 99% of SHS-users said they would switch to grid electricity. Among households without access to electricity, 70% would choose grid electricity and 30% would choose solar. This last percentage may be high due to the ignorance surrounding the small number of lights that can be used with a SHS but it does also indicates potential customers for SHS.

3.1.2 Cooking: Fuels presently used and fuels households would like to switch to

For cooking, the diversity of fuels used is greater than for lighting. 59% of SHS-users rely on paraffin as their main cooking fuel, 27% use gas and 12% use fuel wood. Amongst grid electricity users, 20% (only) are using electricity for cooking, 38% use paraffin, 14% gas and 28% use fuel wood.

Households using electricity for cooking are a relatively small number as is verified by most research on newly electrified households (Prasad & Ranninger 2003).

SHS-users and grid households also use gas for cooking 27% SHS-users (13% have a gas stove without an oven and a further 6% have a gas oven). These figures compare with grid households where 14% of households are equipped with a gas stove with or without an oven.

Asked for the fuel they would switch to for cooking (Table 3.2) 93% of SHS-users would switch to electricity. One household would switch to solar which probably refers to a solar cooker. 2% would switch to or continue to use gas.

96% of grid-users would switch to using electricity for cooking. This percentage compared with the 20% actually using electricity for cooking shows a substantial suppressed demand. 75% of non-electrified households would switch to grid electricity for cooking, 25% choosing solar. It seems likely that this latter group had not understood the limitations of solar power.

3.1.3 Water heating and space heating: Fuels presently used and fuels the household would like to switch to

Water and space heating fuels, as for cooking, follow a similar multi-fuel-use pattern for each sub-sample. 10% of grid households use electricity for heating water but these are the only households to do so. Otherwise, electricity is not used at all for heating water or space heating. Paraffin and wood are the predominantly used fuels by all households for these purposes. Again, a large proportion of households, given the opportunity, would choose electricity for these purposes.

3.1.4 Refrigeration: Fuels presently used and fuels households would like to switch to

A small minority of surveyed households own electric fridges or freezers. 14 of the 51 grid electrified households use an electric fridge. Among SHS-users who have fridges, 82% use gas as the main fuel. 3 non-electrified households also have a gas fridge. The majority of all of these households would choose electricity for refrigeration should they have the opportunity. (Table 3.2)

3.1.5 Ironing: Fuels households presently use and fuels households would like to switch to

The fuel used for ironing again underlines the predominant use of paraffin as the main fuel. 72 % of SHS-users, 56% of grid-users and 69% of non-electrified households rely on paraffin for ironing. The majority would prefer to use electricity, although, curiously, 19% of non-electrified households stated that they would choose solar electricity if the opportunity arose. No doubt they have little understanding of the limitations of solar power.

3.1.6 Media applications: Fuels households presently use and fuels they would like to switch to

For powering a TV set and radio or HiFi, the majority of SHS households use their SHS although 14% use a car battery and 3% use a generator. Not all grid households use grid electricity for running the TV. One household uses car batteries. 96% of non-electrified households use car batteries for powering the TV. 94% use dry cell batteries for the radio.

Several elements are of primary interest in the use of various fuels for basic household needs:

? There are currently no alternatives to multiple fuel use for poor rural households. For SHS-users, the limited power supplied by solar means that every SHS household must provision itself with paraffin and/or gas.

? Grid households continue to need supplies of other fuels after electrification primarily because of income constraints.

? This amounts to a large local demand for paraffin, gas and fuel wood. Section 8 deals with the substantial costs of these fuels.

The desire for access to grid electricity is universal amongst households interviewed.

4. Application for and installation of non-grid and grid electricity

This section deals with questions relating to the application by the household for a solar home system, the installation of the system, the household's knowledge and comments about the contract signed with the service provider, the household's views and opinions concerning the service fees, and the perception and satisfaction of the running of the solar system in their home. A total of 57 questions, were related to these particular issues. Where relevant, the same questions were asked of grid-users.

19% of the sub-sample households had been using their solar system for 2 years at the time of the interview. A further 20% had been users for a year or less making 18 months the average length of time households had been users. The majority of grid-electrified households had had electricity for more than two years at the time of the interview. Thus, all household had adequate experience to be able to respond to the questions.

4.1 Application for service

Most households (57%) had found out about solar home systems from an Eskom-Shell agent and a further 19% had obtained the information from an Outlet or a Resco office. Friends, family and neighbours were however, a non-negligible source of information (13%) on where to apply for solar home systems. Most households had applied for one solar system although 9% had applied for two systems and 9 households (4%), had applied for 3. The reason for applying for more than one system was motivated by the large number of rooms in the homestead. For five households the reason was

that they had spaza shops.[8] Two households however, had thought that having two solar systems would cover all their energy needs.

4.2 Solar home system installation

The installation of the system in the majority of cases followed within three weeks of the application having been made. For 45%, the installation was made within 7 days or less after the application. Given the problems of access by road to the homesteads this is a surprisingly high rate of performance. For a further 24%, the delay before installation was between 8 and 21 days. It had taken as long as one month for a further 21%. There were a few cases where the installation had taken much longer than was usual. (For 2 households it had taken as long as five months – but no doubt there were particular reasons for this). The average number of days prior to installation was 18.

The comparison with grid electricity users is interesting. They had had on the whole a much longer wait to obtain a connection. For 24 % of the 51 grid-users interviewed, they had a one-month wait. For half of the sub-sample, the waiting period was 15 months.

There was a high level of satisfaction (97%) concerning the location in the home of the SHS unit or the grid meter.

The majority of households (72%) had no complaints about the installation of their system. 28% of households said that their main complaint was that at times, the system was not working and that the installation was expensive. There was an equally high level of satisfaction amongst grid-users concerning the installation and the location of their meter.

4.2.1 Knowledge of the solar system

There were positive responses to most of the questions relating to how well the installer or technician had explained the functioning of the solar system. (Table 4.2.1)

Table 4.1: Levels of understanding of the SHS

Questions asked of households using SHS	*Yes*	*No*
Did the technician explain to you:		
How the SHS works?	99.6%	.4%
How to take care of the SHS?	98%	2%
How to connect appliances?	97%	3%
Do you know which appliances can be connected to the SHS?	95%	5%
Are you responsible for maintaining the water level in the battery?	3%	97%
Are you responsible for cleaning the panel?	19%	81%

There were relatively high levels of understanding of the functioning of the solar system when the technician who had undertaken the installation explained it. There was less agreement on whether or not the household had received any written information about the solar system Table 4.2.2.

Table 4.2: Recollection of having obtained written information concerning the SHS

Did you receive written information about the SHS?	*%*
Nothing	8
Users manual	51
Pamphlet	41
Poster	.4

[8] This is of special interest since it has not yet been clarified by the NER whether shops will be eligible for capital subsidies.

Just over half of the SHS-users in 2001 had received a manual. In the early stages of installing solar home systems on a large scale, it is possible that not all households had received such a document and the distribution of information has greatly improved since.[9]

4.3 SHS ownership

The answers to the question, " Who owns your solar system" were insightful. 8% of households answered that they did not know. 5.6% of households thought that t**hey** owned the solar system, thus demonstrating that they had not grasped the basic principle of a "fee-for-service". Another indication of the a lack of "understanding" is spite of answering "yes" when asked if this was explained.

Table 4.3: Knowledge of ownership of the SHS

'Who owns the SHS once installed?'	
Household	6%
Eskom-Shell	84%
Government	2%
Don't know	8%

4.4 Service contract

Over 80% of SHS-users recall having signed a contract on receiving their system. 17% however, do not recall having signed any such document. In 2001, the contract appeared on the reverse side of the application form filled in by households and has since been amended and produced as a separate document. The return visit to the households revealed a greater awareness of the contract. The answers to the question: "Did someone explain the contract to the household" is answered in a similar way. 23% of households said they did not understand the terms of the contract.

Table 4.4: Knowledge of the contract with Eskom-Shell

	Yes	***No***
Did you sign a contract with Eskom-Shell	83%	17%
Did someone explain the contract?	76%	22%
Did you understand the terms of the contract?	77%	23%

If people did in fact understand the terms of the contract why is it that so many thought that the payment system was similar to the grid pre-payment system?

4.5 Service fees

When asked what they thought about the cost of the pre-payment token for the solar system, the vast majority of households thought it was too expensive, (91%). A small minority 7%, thought the cost was reasonable and only 2% considered it cheap.

When asked how much the household thought they should pay for the token, the range of responses ran from R5 to R 47. Just under 30% of households considered R20 to be the price they should be paying for the solar system token. A further 22% considered R30 to be the appropriate amount to pay. Only one household specified a figure higher than they were currently paying.[10] The totality of SHS-users consider that the price they are actually paying for the service fee is more than it should be.

[9] Communication from the Managing Director of Eskom-Shell.

[10] At the time of the survey, the monthly service fee was R52, subsequently increased to R58.

Table 4.5: Amount per month SHS-users think you should pay for the fee-for-service token

Rand per month	*Number*	*%*
5	6	3
10	44	20
15	11	5
20	65	29
25	27	12
30	50	22
32-40	14	5
42-47	5	2
100	1	0.4

The comparison with grid electricity users is interesting in that there is a wide range in the amounts that grid households apparently paid for their connection fee and are paying per month for electricity use. 78% paid R100 or less for the connection. Under one quarter (17%), of grid households are currently paying R20 per month for their electricity. 16% are paying less than R10 a month. A further 26% are paying R50 per month. Only two households pay more than this. Half of the grid-users think that the amount they are paying per month for a token is the amount it should be.

Although one of the criteria for selection of potential SHS customers was the precondition that the household includes a member earning a regular salary, it is notable that 23% of the SHS household members who actually pay for the token, does not have a regular income.

5. Solar electricity, grid electricity use, households' expectations and satisfaction

This section examines the more subjective aspects associated with using a solar system. It includes the results from" classic" satisfaction measures, the expectations concerning appliances and preconceptions households had about SHS. These latter individual items that were located at various points in the interview are far from coherent or consistent when compared with the classic question "are you satisfied or dissatisfied" with the system (there were seven such questions in the questionnaire). The discrepancies reveal considerable ambivalence on the part of respondents. Attitudes and perceptions may still be in the process of forming[11]. Problems related to the functioning of the SHS and maintenance services are discussed further in Section 6.

Levels of satisfaction were measured through many other questions throughout the interview: The numbers of hours the system can be used daily, the various problems which have arisen in operating the solar system, delays in repairs, the payment system etc. All "count" in the balance of how the household in the end evaluates the gains and inconveniences of their system.

5.1 Customer "satisfaction" measured as a dichotomy

Periodically during the interview, respondents were asked to say how satisfied or dissatisfied the household was with various aspects of the solar system[12]. The levels of satisfaction on seven items are given in the table below.

[11] The complexity and diversity of attitudes towards the solar system and the ambivalence that exists are revealed in the follow-up survey with those households whose systems had been removed and with those who continued to use their solar system. After the initial uncertainties about operating the system, some households identify with the system as "if it were their own". Taking it away from them has had quite dramatic consequences in some cases. For others, where the arrival of the grid was imminent, the removal of the SHS was a relief. These aspects are discussed in a pending report.

[12] "Satisfaction" is difficult to measure by a simple dichotomous variable. In the follow-up survey; respondents were able to choose between several levels of satisfaction: 'highly satisfied', 'satisfied', 'not satisfied' and 'not at all satisfied'..

Table 5.1 Levels of customer satisfaction with different aspects of the SHS

Items measuring satisfaction	*Yes*	*No*
Have complaints about the installation?	28%	72%
Satisfied with the location of the unit in the house?	97%	3%
Satisfied with the contract?	83%	17%
Satisfied with the outlet?	89%	11%
Satisfied with the location of lights?	94%	6%
Satisfied with the services of the technician?	82%	16%
Satisfied with the appliances they can use with the solar system?	43%	57%

The levels of customer satisfaction appear to be relatively high on all aspects of the solar systems except for the appliances that can be used with the system. Other measures of customer satisfaction yield a rather different picture.

5.2 SHS electricity use

One third of SHS-users use their solar system to its limits, that is, to its full capacity in terms of number of hours of use per day and the number of appliances connected. In contrast, grid-users are restricted in their use of electricity only by what they can afford to pay.

5.2.1 Willingness to pay more for a larger solar system

It is significant that 55% of SHS-users said that they would be willing to pay more for a larger system. This corroborates the 70% who said that the number of hours when they can use the solar system is too short. The answers to the question "what would you use the larger solar system for" are given in the following table.

Table 5.2: Users' views of use of a larger system

What would they use a larger system for?*	
More inside lights	64%
More outside lights	12%
Watch videos	8%
Watch TV	13%
Colour TV	2%
Cook	0.4%
* The selection of responses was provided.	

The figures are a measure of how well respondents had understood the limits of solar power. They also reflect the basic need for more lights than the three inside lights available on the 50Wp system. (Recalling that the average number of rooms in households with SHS is 6.4).

The majority of SHS-users use all three of their inside lights and their outside light on a daily basis and for the majority of SHS-users, (71%), the use of the solar system is the same in summer and winter.

Other than the occasional interruptions of the grid service, grid-users do not think on similar lines. Their constraints are no less real but are more easily comprehensible. They may lack sufficient money to renew their card at the end of the month but they are not paying for the electricity they are unable to use. These issues are dealt with in the paragraphs below.

5.3 Electricity know-how of SHS-users

Despite some understanding of the power limits of the solar system, only a minority of households, 37%, affirm that they know how to check the credits on the system. 63% admit that they do not

know how to do it despite the affirmation that the technician had shown them how the system worked.[13] Nor can customers identify what is wrong when the system is not working.

5.4 Expectations concerning appliances

Misunderstandings about what appliances could be used with the solar system also demonstrate the lack of basic knowledge about solar power. SHS users said that the technician installing the system had explained how it functions, yet they have not always grasped the essentials.

Table 5.3: Appliances SHS households expected to use with SHS

Appliances expected to be used	
Stove	61%
Heater	2%
Kettle	1%
Large TV	31%
Video	1%
HiFi	5%

That 61% of SHS households expected to be able to use a stove with their solar system is astonishing. In part, this may have resulted from the excitement of making an application for a SHS that led households to ignore some of the features of the system. Or the overly enthusiastic salespersons, whose renumeration was based on the number of systems that were "sold". When asked if the technician had explained which appliances could be connected to the SHS, 95% of respondents had replied "yes" (Table 4.1). It is not surprising to find the expression of a good deal of disappointment in some of the respondents' replies. A closely related question asked SHS-users to explain their satisfaction or dissatisfaction in relation to appliances.

Table 5.4: Customers' explanations for satisfaction or dissatisfaction with the appliances that can be used with the SHS

Positive responses	
Bright lights	9%
Makes life easier	14%
Saves money	2%
Meets energy needs	10%
Negative responses	
Can't cook	18%
Can't meet all energy needs	46%
Unreliable	1%
Need to buy appliances	2%

5.5 Service level and problems with the SHS

The different components of the SHS are known to have had some technical weaknesses most of which have been ironed out over the years. The principle of fee-for-service is based on the idea that for whatever kind of problem, the Eskom-Shell maintenance team is responsible for repairing it. In practice, this was not without obstacles. The distances and road conditions make speedy maintenance extremely difficult and there could be delays in obtaining replacement parts. From the customers' point of view, the delays meant frustration. They pay the monthly service fee whether they are using the system or not.

[13] Many studies bear witness to the fact that information about the operation of equipment is rarely transmitted in a single effort but requires repeated and varied "doses."

When asked if they had had problems with the SHS, more than half (56%), said that they had had problems[14]. Different items related to these problems are presented in the table below.

Table 5.5: Incidence of problems with the SHS

Items relating to problems	*% SHS-users responding yes*
Had problems	56%
Able to identify SHS problem	44%
Know what to do when there is a problem	86%
Have you ever tried to fix problems	0.4%
Reported the problems with SHS	99%
Have the problems been solved?	86%
Are any of the problems still unsolved?	29%

Less than half of the SHS-users are able to identify the problem with their system. No doubt, this increases their sense of irritation when things go wrong. Up to the time of the survey only one household admitted to having tried to fix the problem themselves.

For 29% of SHS households, there are problems that remain unsolved. (One household had had a non-working system for as long as six months.)

The following tables provide more detail information concerning problems with the SHS.

Table 5.6: Where problems with SHS are reported

Outlet	69%
Resco	18%
Area manager	6%
Eskom/Shell H/office	4%
Inspector	3%

Table 5.7: Number of times have had a problem

Once	20%
Twice	18%
Thrice	15%
More than three times	22%
Never	25%

Table 5.8 Frequency with which problems were mentioned (multiple responses)

Card not working	44%
Low voltage	62%
Card not lasting	34%
Lights not working	55%
Non attendance by inspectors	5%

[14] In the follow-up survey, more detailed questions were asked relating to problems with the specific components of the SHS

Table 5.9 Frequency of checks on the SHS

More than once a month	2%
Once a month	63%
Once in six months	32%
Only when is a problem	2%

Although 25% of households have never had a problem with their system (Table 5.7), as much as 37% have had three or more problems with their systems. The majority of SHS-users report problems to their nearest outlet or Resco centre. Customers were asked to choose from a list of possible problems those that corresponded with their problems (Table 5.8). Low voltage was the most frequently identified problem, followed by lights not working.

Customers were also asked if they had ever stopped paying the monthly service fee because the system was not working. 22% of respondents stated that they had stopped paying for this reason and for 54% of these, the duration of non-payment had been three months or more. From Table 5.9, it appears that inspectors do not always manage to check the systems once a month. For 32%of households the frequency of system checks had been once in six months. When asked whwn the system was last checked, 47% said it had been checked 'last week' or 'last month'. A further 32% stated it had been checked during the last 3 months. More over, 82% of customers stated that they were "satisfied" with the services of the technician (Section 5.1).

5.6 Likes and dislikes about the SHS

It is important to note that the majority of SHS-users specified what they liked most about the SHS ***and*** what they disliked most[15].

Table 5.10: Likes and dislikes of the solar system

What was most liked:	
Lights	57%
TV	15%
Radio	10%
Affordable	5%
Security	5%
Study at night	1%
Reliability	1%
Nothing	7%
What was disliked most	
Can't cook	47%
Expensive	26%
Low Voltage	17%
Too few lights	2%
Can't use fridge	1%
Faulty	2%
Nothing	4%
Everything	1%

The solar lighting is what is most liked about the SHS and the use of TV and radio are appreciated. But for just under half of the respondents, the fact that they can't cook with the SHS is the thing that is disliked most. Those who think it is too expensive join them.

[15] Only the respondent gave the answers to this question. Children or other members of the household might well have had different opinions.

5.7 Affordability

It is difficult to clearly define "affordability" because what is affordable depends on available income *and* other items and commitments of the household. It is a subjective measure. It also depends on the notion of "value for money". Since most poor households are run on a very tight budget, something may be unaffordable because there is no room for manoeuvre. What SHS households have to do without, now that they have solar energy, is discussed in Section 10.

6. Payment of electricity services

The costs of the fee-for-service and customer perceptions of the service were briefly discussed in Section 4. The cost of tokens for both SHS-users and Grid-users is discussed in Section 8. Here, a number of aspects of payment are discussed: Where households buy their tokens, how far away the outlet is, how often households buy tokens and who purchases them. All of these factors can and do influence the overall satisfaction or dissatisfaction of SHS-users. Where appropriate, the replies of grid-users to the same questions are given in the tables below.

6.1 Purchasing of tokens

Table 6.1: Frequency of purchase of tokens

	SHS-users
Every month	97%
Every second month	1%
When money is available	1%

Table 6.2: When the token is bought

	SHS-users	*Grid-users*
Before new month starts	73%	8%
First day of month	13%	4%
First week of month	5%	55%
Pension day	9%	33%

There are clearly quite different patterns of token buying when comparing SHS-users and grid-users. Almost three quarters of SHS-users buy their token before the new month starts. For grid-users, the majority buy tokens in the first week of the month or for a third of them, on pension day.

Table 6.3: Persons who pay for the token

	SHS-users	*Grid-users*
Husband	17%	18%
Wife	17%	45%
Household	60%	29%
Son/Daughter	5%	6%
Relative	1%	2%

For SHS-users, the money for the token is most likely to come from the household budget, whereas for grid-users, it is frequently the wife who pays the electricity bill.

The payer is more likely to live at home in the case of grid-users, whilst 11% of payers live away from home in the case of SHS-users.

Table 6.4: Place where person buying the token lives

	SHS-users	*Grid-users*
At home	88%	96%
Away from home	11%	4%

Table 6.5: Does the token payer earn regular income ?

	SHS-users	*Grid-users*
Yes	78%	73%
No	23%	28%

Given the requirement for SHS applicants that at least one person in the household has a regular income, it is surprising that 23% of those paying for the solar system do not earn a regular income.

Table 6.6: Customer suggestions to make payment easier

	SHS-users
Token cheaper	88%
Pay weekly	3%
Pay part of the month	1%
Pay every two months	7%

There is, in the minds of SHS-users, an overwhelming sentiment that the token is too expensive. 88% would suggest making the token cheaper.

Table 6.7: Expected duration of payment for the SHS

	SHS-users
As long as have SHS	14%
Until grid	73%
Until ownership of SHS	12%

It seems likely that many SHS-users see the solar system as being a lead-up to obtaining grid electricity. More disturbing is the fact that 12% are under the impression that they will eventually own their system.

Table 6.8: Where tokens are bought

	SHS-users
Outlet	82%
Resco office	10%
Eskom-Shell H/Office	1%

The majority (82%) of SHS customers buy their token at an outlet. In terms of strengthening services and the image of the service provider, a substantial effort could be directed towards these outlets. Although 88% of SHS-users say they are satisfied with the outlet, 12% are dissatisfied partly because no one at the outlet is qualified to help on technical problems.

Table 6.9: If the outlet has been closed

	SHS-users	*Grid-users*
Never	77%	75%
Sometimes	22%	26%

Table 6.10: Distance to outlet where token is purchased

	SHS-users	*Grid-users*
Less than 2km	69%	
Less than 5km	17%	28%
Between 6 and 10km	12%	24%
More than 10km	1%	49%

The outlets are within fairly easy distances of the homes of SHS-users although 2km over rough ground can be quite strenuous. The same is not true for grid-users of whom nearly half must travel more than 10 km.

7. Electrical appliances owned by SHS-users and grid-users

This section looks at the type of electrical appliances that are owned by SHS-users and households with grid electricity. SHS-users own an average of 2.3 electrical appliances that can be used with the solar system. Grid-users own an average of 2.6 electric appliances. The table below summarizes the major differences in the type of electrical appliances owned by the two sub-samples.

7.1 Ownership and use

Table 7.1: Ownership of electrical appliances: SHS and grid-users

Types of appliances	*SHS-users N=214*	*Grid users N=40*
Radio	77%	35%
Radio-cassette	16%	25%
Hi-Fi	34%	42%
Colour TV	15%	40%
Black & white TV	61%	23%
Cell-phone charger	20%	15%
Fridge/freezer	0	35%
Hot-plate	0	30%
Iron	0	20%
Video	0	0

The fact that SHS-users cannot run a fridge, use a hot plate or an iron is a source of considerable disappointment as discussed in Section 5, Table 5.10.

The following Table 7.2 summarizes the differences according to sub-samples in the ownership and use of TV. 65% of SHS-users have a colour or black and white TV and some SHS households use car batteries or a generator to run them.

Table 7.2: Ownership and use of TV: SHS-users compared with grid-users and non-electrified households

	SHS-users	*Grid -users*	*Non-electrified households*
Have a TV (Black and white or colour)	65%	41%	46%*
Watch daily	89%	91%	85%
Watch the news daily	83%	81%	70%
Approximately four hours/day	75%	95%	91%
Same in winter and summer	81%	100%	100%
% school children watching frequently	43%	38%	38%
* 96% of non-electrified households use a car battery to run the TV			

7.2 Ownership of electrical appliances that cannot be used with solar

As many as 54% of SHS-users own electrical appliances they cannot use with their solar system. These households own an array of electrical equipment including kettles, hotplates and stoves, irons, fridges and freezers, TVs, radios and videos. The impatience to obtain grid electricity is strong and is understandable because of the number of unused appliances.

8. General use of fuels and energy sources

There are no less than 9 different fuel sources that rural households commonly use to meet their various energy needs (see Section 3 "Main end-uses of various fuels"). The primary fuels are, candles, paraffin, gas, coal, fuel wood, dry-cell batteries, car batteries, generator fuel, and biomass fuels such as crop residues and dung. In the survey data reported here, all of these fuels were used by various numbers of households. Questions relating to the use of these fuels require a host of subsidiary questions that are listed below:

- the quantity of fuel bought at one time;
- the frequency of purchases;
- the price paid according to the quantity bought;
- the length of time the fuel lasts;
- any extra quantities bought before the end of the month;
- all the uses to which the fuel is put;
- where the fuels are bought and the distance/time of the return journey;
- the cost of the return journey.

Only when the answers to these questions have been analysed, is it possible to arrive at the household monthly expenditure for each type of fuel the household uses.[16] A total of all expenditures on all fuels used was calculated for each household and was then be expressed as a percentage of disposable income.

[16] In the follow-up survey where these questions were repeated, interviewers were instructed to make the calculation of the monthly cost of each fuel (verified later by computer calculations) with the help of the respondent. Not surprisingly in many cases, making this calculation was a novelty for the respondent. Some households found it difficult to calculate figures for a whole month especially if there was no regular monthly wage. For most households, the figures for the cost of a fuel, such as paraffin, for the period of one month came as a surprise.

8.1 Cost of solar and electricity tokens

The payment for solar and grid electricity involves two different principles: one is a fixed monthly payment (for SHS-users) the other is based on the quantity of electricity used (grid-users). Many SHS-users would have preferred to pay in the same manner as grid-users, paying for only the power they have used. For the majority of SHS-users, the token is considered much too expensive

The operational subsidy of R40 would have reduced the monthly amount paid by SHS-users to R18, closer to the cost per Kwh paid by grid–users but at the time of the survey, Eskom-Shell had not agreed to implement the operational survey for their customers.

SHS-users in the Eastern Cape, (who began paying R52 per month) continued to pay R58 a month for the fee for service .[17].

Grid households quoted a range of prices paid for of the installation of the grid from R60 and R65. However, 78% of the grid-users in the sub-sample had paid less than R100 for the installation. (SHS-users paid R110). All of the grid-users has a 20 Amp supply. Table 8.1 below gives the amount grid households are paying per month for their electricity.

Table 8.1: Amount paid monthly for the electricity token (grid-users)

Rands	*Grid-users*
R5-R15	18%
R20	33%
R30-R49	22%
R50	24%
R70+	4%

8.2 Costs and quantities of other fuels besides electricity

Each household has its specific "mix" of the fuels other than electricity that they use for various purposes. (The main fuels used for different household purposes were discussed in Section 3).

The following table summarizes the number and percentage of households in each sub-sample which use a particular fuel and presents the mean spending on that fuel for SHS-users, grid-users and non-electrified households. A few points need to be remembered:

? there are wide variations in the amount of fuel households are able to buy at one time. Some households buy one candle a day while others stock up on packets of 6. Some households only buy candles when the solar system is not working. Some buy paraffin in 25 litre cans while others buy one, two or three litres at a time. Some households buy their fuel wood in head loads. Others buy by the tractor load. The impact of this on the household budget is, of course, all-important. Buying in small quantities is more expensive than in larger quantities.

? there are very substantial differences in the prices households are paying for any of these fuels whether it is paraffin, dry cell batteries or fuel wood. In calculating the "average" expenditure for a given fuel, these differences become less visible. Taking the case of 5 litres of paraffin, the range is from R10 to R27.50 with two peaks – at R15 and at R20. For fuel wood the differences in prices are even more marked. For a bakkie load of fuel wood, prices run from R36 to R300.

[17] The fact that SHS-users in the Eastern Cape had heard via the radio that other SHS-users in other provinces were paying just R18 created much bad feeling among customers, expressed in the follow-up survey.

Table 8.2: Mean monthly household expenditure on each fuel according to sub-samples (not counting the cost of the return journeys to buy fuel)

Type of fuel	*SHS-users (N=232)*	*Grid-users (N=51)*	*Non-electrified households (N=65)*
Candles	*N=165 (71%)*	*N=51 (100%)*	*N=59 (91%)*
Min	R0.8	R3	R1
Max	R68	R28	R100
Mean	R18	R9	R27
Standard deviation	10.08	6.597	21.27
Paraffin	N=207 (89%)	N=50 (98%)	N=58 (89%)
Min	R3	R4	R2
Max	R260	R263	R127
Mean	R55	R49	R51
Standard deviation	28.13	37.91	49.46
Gas	*N=112 (48%)*	*N=9 (18%)*	*N=8 (12%)*
Min	R5	R28	R20
Max	R395	R127	R157
Mean	R90	R68	R69
Standarddeviation	60.50	29.40	49.46
Coal	*N=11 (5%)*	*none*	*none*
Min	R18		
max	R70		
Mean	R36		
Standard Deviation	16.82		
Fuel wood	*N=77 (33%)*	*N=25 (49%)*	*N=21 (32%)*
Min	R2	R9	R8
Max	R300	R150	R200
Mean	R102	R60	R101
Standard deviation	74.47	36.68	66.89
Dry-cell batteries	*N=74 (32%)*	*N=12 (24%)*	*N=41 (63%)*
Min	R2	R1	R10
Max	R68	R17	R70
Mean	R19	R13	R19
Standard deviation	14.97	5.52	12.23
Car battery	*N=33 (14%)*	*One case*	*N=20 (31%)*
Min	R5		R5
Max	R60		R221
Mean	R15	R10	R29
Standard deviation	14.95		57.00
Generator fuel	*N=12 (5%)*	*None*	*One case*
Min	R13		
Max	R404		
Mean	R131		R5
Standard deviation	117.43		

From the data shown in Table 8.2, several important comments can be made. Firstly, a large number of households are spending monthly a considerable amount of money on fuels other than electricity.

A large majority (89%) of the total number of households (348) uses paraffin as one of their main fuels; 82% of these households use candles; 83% use fuel wood (collected or bought).

Generator fuel, bought fuel wood and gas are particularly expensive. The average amount spent by households on each fuel type varies considerably according to whether they have a SHS, have grid electricity or have neither. Non-electrified households spend on average, R27 per month on candles compared with R18 for SHS-users. Not surprisingly, the average expenditure on candles is considerably less for grid-users. The relatively high spending by SHS-users on candles[18] is no doubt due to the fact that the solar system comes with only three light bulbs and as noted earlier, most dwellings have more than three rooms requiring lighting.

For the majority of these households, the monthly expenditure on paraffin is high, corresponding with the quantities that are used for cooking, water heating and ironing. The same applies for gas. Nearly 50% of SHS households use gas, compared with 18% for grid households and 12% for non-electrified households. Households using gas for cooking and a different size bottle for the fridge, may be spending as much as R395.00 per month on gas.

Looking at the differences in means between the three sub-samples, it is clear that for all fuels except two, (candles and car batteries), the highest average expenditure on fuels is for SHS-users. Possibly, the higher incomes received by this sub-sample in part explains the greater spending on these fuels. SHS households also have fewer members that should tend to reduce the amount of fuel they need.

What SHS-users say about which fuels they have been using less of since receiving SHS throws more light on the impact of solar and is discussed in Section 8.5 below. A comparison of total monthly expenditure on all fuels and the percentage of household income devoted to fuel-purchases will be discussed in Section 10.

8.3 Sources of purchased fuels

Table 8.3: Where paraffin and gas are bought according to fuel type and sub-samples

Paraffin	*SHS-users*	*Grid-users*	*Non-electrified households*
In town	63%	54%	33%
Local shops	32%	46%	63%
Spaza shops	4%	0	4%
Gas			
In town	95%	88%	92%
Local shops	5%	13%	8%
Spaza shops	0	0	0

There are quite large differences in where households purchase their fuels. Most often purchases are made in town, rather than in the local shops or spaza shops. This is particularly true for gas, a fuel that is probably not available locally. However, for paraffin purchases, non-electrified households are much more likely to buy from the local shops and in smaller, more frequently purchased quantities. Surprisingly, spaza shops are used less frequently for purchasing these fuels. It must be noted that Eskom-Shell does *not* supply these fuels as the DME had originally hoped.[19]

8.3.1 Distances and cost of return journeys to purchase fuels

Buying fuels "in town" involves the household in a journey of various distances and an additional cost. Households were asked about these distances and the usual cost of the return journey. Although other goods are likely to be purchased at the same time, the cost of these journeys can be high. Of

[18] It was noted in the course of this survey that households may systematically exaggerate the number of candles they buy each month.. Households were asked how many hours per day do they burn candles, the number used at one time and the number of rooms in which candles are used. This provided a total of burning hours of candles. Assuming that in ideal conditions a candle burns 8 hours, it is possible to estimate the number of candles used per month.

[19] In an interview, the Managing Director of Eskom-Shell pointed out the potential damage to local sales people should Eskom-Shell become a prime supplier of paraffin, gas, and other fuels.

course the same applies to SHS-users who must travel some distance to report problems to the local ESCO. Households could save money on these trips if outlets for these basic fuels could be established nearer to their homesteads.

The average cost per month of making these journeys to purchase fuels is considerably higher for SHS-users, (R156) than for non- electrified households (R132) who tend to buy their fuels locally rather than "in town". Grid-users on average pay less since they make fewer journeys to buy fuel, Table 8.4 below. All in all, journeys to buy fuel add up to a sizeable amount to be added to the cost of the purchase.

Table 8.4: Average distances travelled to purchase fuels and average cost of the return trip

	SHS-users	*Grid-users*	*Non-electric households*
Paraffin			
Distance in kilometres*	Min 1km	Min 1km	Min 1km
	Max 70km	Max 45km	Max 33km
	Mean 16 km	Mean 8km	Mean 7km
Cost of the return trip	Min R1	Min R5	Min R6
	Max R50	Max R20	Max R16
	Mean R16	Mean R10	Mean R12
Gas			
Cost of the return trip	Min R1	Min R5.00	Min R6
	Max R50	Max R20	Max R16
	Mean R16	Mean R10	Mean R13
Charging car batteries	Min R7		Min R11
	Max R140		Max R180
	Mean R16		Mean R41
Total monthly cost of all return journeys	Min R2	Min R8	Min R3
	Max R776	Max R274	Max R414
	Mean R156	Mean R102	Mean R132

*Notes: The price of gas does not include the cost of buying the bottle. Instead of distances travelled to buy gas, respondents were asked how long it takes in terms of part of the day. For the majority of respondents, this journey to buy gas takes half a day.

8.4 Estimated fuel replacement with solar or grid electricity

In theory, the use of solar energy for lighting should have a measurable impact on the quantity of other fuels used for lighting and media. In many cases, these reductions may be too small to measure if the homestead has many rooms that have to be lit with candles, paraffin or gas, which most households in fact have.

As an alternative way of detecting changes in fuel-use households were asked if there were any fuels they were using less of since obtaining solar or grid electricity and if so, which fuels these were. These were based on people's perceptions rather than accurate calculations.

Table 8.5: Fuels used less since obtaining solar or grid electricity

Are there fuels used less?	*SHS-users*	*Grid-users*
Yes	62%	94%
No	38%	6%

Table 8.6: Fuels used less since obtaining solar or grid electricity (multiple responses possible)

Respondents mentioning the fuel	*SHS-users*	*Grid-users*
Candles	86%	100%
Paraffin	52%	42%
Gas	5%	42%
Dry-cell batteries	25%	12%
Car battery	30%	3%
Generator	3%	0

Table 8.7: Changes in expenditure on fuels since obtaining solar or grid electricity

	SHS-users	*Grid-users*
Spending more money	21%	2%
Spending less money	48%	84%
Same	26%	4%
Don't know	4%	10%

9. Household lighting in practice

The possibility of extending day light-hours with the use of artificial light, whether grid, solar, paraffin, gas or candles has been of great importance to all rural households permitting a wide range of activities that would otherwise have been impossible. This section deals with how SHS-users and grid-users see these advantages in comparison with the more traditional forms of lighting.

9.1 Coverage of household lighting (number of rooms, number of lights)

SHS-users homesteads are considerably larger than grid-users' dwellings as was discussed in Section 2.6 and they are predominantly a mixture of traditional huts and other buildings. Lighting of rooms is far more of a problem than for single house structures. The average number of rooms is 6.4 for SHS-users compared to 5.2 for grid-users. For many SHS-users, the number of lights (3 inside and 1 outside) supplied with a single 50Wp system is not enough to fulfil their needs. 10 households have had more than one system installed and three households have installed three systems to better cover their lighting needs.

9.2 Times lights are switched on and off (differences between seasons)

Not surprisingly, there is a good deal of uniformity concerning the time at which lights are switched on in summer. 57% of households switch on the lights at 7pm in the evening and a further 16% at 7:30pm. The position and direction of the homestead probably influences the time of needing light. Switching off times are more varied. Just over 1/3 of households turn off their lights at 9pm. A further 28% switch off at 10pm. A very similar pattern is observed for grid-users.

Switching on of lights in wintertime is more varied for SHS-users. There is a peak of putting on the lights at 6pm with two further peaks at 6:30pm and 7pm. Grid-users switch on their lights a little earlier at 5:30pm but for the majority it is at 6pm.

There is little declared variation in use of lighting use according to the season. 71% of SHS-users say they use lights in the same way in winter and summer. A quite large number of households whether in summer or winter use their lights in the very early mornings as early as 03:00am or 4:00am in some cases where the possibility of turning on a solar light must be greatly appreciated.

9.3 Attitudes towards electricity waste

72% of grid-users switch off the lights in rooms where no one is present. The reason given for 72% of these is to save electricity or because of habit, but a quarter say this is for reasons of security. A slightly smaller percentage of SHS-users.(66%) say they turn off lights in rooms not used. 52% say that it is to save electricity and the solar battery whereas 36% say that it is for security reasons.

9.4 Lighting quality comparisons between different fuels

Questions were asked of both SHS-users and grid-users concerning comparisons between lighting using different fuels. Not surprisingly, 100% of grid-users considered that grid electricity is brighter than candles. They thought the same concerning paraffin lights. When it came to gas, 77% thought that electricity was brighter than gas but 22% thought the two fuels provided about the same quality of light.

There was less than unanimous agreement that solar lights are brighter than candles, with 2% believing that they were about the same. As far as paraffin lights are concerned, 94% consider them to be darker than solar lights and 5% consider the quality to be the same. Gas, as for grid–users, leaves SHS-users in more doubt.. 42% think that solar lights are brighter than gas whereas 38% consider them to be darker. The majority of SHS users state that solar lighting is darker than the grid with 19% considering them about the same.

9.5 Activities for which SHS lights are used

Not surprisingly a quite wide range of activities are undertaken using solar or grid lighting as the table below shows.

Table 9.1: Activities using solar or grid lighting at the time of the survey

*Activities**	*SHS-users*	*Grid-users*
Socialise/rest	80 (68%)	9 (22%)
Watch TV/Listen to radio	108 (92%)	29 (71%)
Read/write	72 (62%)	7 (17%)
Homework/study	84 (72%).	18 (44%)
Household chores	54 (46%)	11 (27%)
Craft work	7 (6%)	2 (5%)
Bath/prepare for work	19 (16%)	18 (44%)
* These activities were chosen from a pre established list and multiple responses were possible		

Amongst SHS-users the most frequently indicated activity using solar lights was to watch TV or listen to the radio. To socialise or rest was also a frequently cited activity as was homework and study. There were fewer citations of socialising amongst grid-users and more frequent mention was made of activities such as preparing for work.

9.6 Inside and outside lights

SHS-users are more likely than grid-users to have outside lights, no doubt because an outside light is supplied with the system. 3% however say they have no outside light. Only 63% of grid-users have an outside light. The majority have only one outside light but as many as half have two. On the whole, SHS-users and grid-users switch on the outside light any where between 5pm and 8pm, but this is likely to depend on the time at which household members return home and perhaps the orientation of the homestead.

10. Socio-economic impacts of solar systems and grid electrification

This chapter compares the energy use patterns of grid, off-grid and non-electrified households and the changes in their fuel-use since they obtained solar power or access to the grid. It provides an opportunity to bring together the threads that have been discussed separately in the previous sections and to look at the wider context of changes in rural people's lives both at home and in the wider community.

10.1 Extent of fuel use and proportion of income devoted to fuel-purchases

All households in the survey, irrespective of their electricity status (SHS-users, grid electrified and non-electrified households), are using a variety of fuels to meet their daily needs. SHS-users are not only multiple fuel users; they are, in comparison with grid-users and non-electrified households, the group that is spending *most* on fuels. Paraffin plays a dominant role in household energy needs, including households with grid electricity. There was ample evidence to show that monthly expenditure on fuels takes up a sizeable proportion of household income.

10.2 Energy expenditure of households

Table 10.1 Total monthly expenditure on all fuels (excluding electricity)

	Min.	*Max*	*Mean*	*Standard deviation*
SHS-users	R12	R776	R157	121
Grid-users	R8	R273	R102	56
Non- electrified households	R15	R414	R133	94

Table 10.2 Total monthly expenditure on all fuels (including electricity)

	Min.	*Max*	*Mean*	*Standard deviation*
SHS-users	R70	R834	R215	121
Grid-users	R27	R309	R133	62

The average total monthly expenditure on all fuels, except electricity is shown in Table 10.2. The average amount spent per month on all fuels (excluding electricity) is considerably higher for SHS-users (R157) than for grid households (R102). It is also higher than for non-electrified households who spend on average R133 per month.

When including monthly spending on the fee-for-service and electricity, the differences between the average expenditure is greater. (R215 for SHS-users compared with R133 for grid-households).

10.3 The proportion of household budget devoted to fuels and electricity

Since there were quite wide variations in total incomes within each sub sample and in the amount spent on fuels, there also is an equally large variation in the proportion of income that is spent on all fuels taken together. Ideally, spending on fuels should have been expressed as a proportion of total household expenditure, but since total expenditure on all items was not asked in the study, income is used as a proxy. Table 10.3 shows the lowest and the highest proportions of income devoted to fuels and the average "weight" of these fuels in terms of income.

Table 10.3: Average proportion of income spent on all fuels according to sub-samples

	Min.	*Max*	*Mean*	*Standard deviation*
SHS-users	2%	63%	16%	13
Grid-users	1%	75%	13%	15
Non- electrified households	2%	78%	25%	18

SHS-users with higher than average incomes devote a smaller proportion of their income to fuels. As one goes down the scale of incomes, the proportion spent on fuels tends to become relatively greater. Obviously, there is a point at which fuels become unaffordable and are no longer purchased or changes are made to use cheaper fuels.

For SHS-users, for instance, the proportion of fuel-expenditure on total income has been calculated for all SHS households. The averages of these values are presented in the table above. Thus the average proportion of income spent on fuels for SHS-users is 16%, for grid-users it is 13% but for non-electrified households it is 25%.

10.4 Information (ownership of radio and TV, extent of use)

The percentage of households owning a TV and a radio was discussed in Section 7. Here, it is relevant to look at TV and radio as a source of information for households relatively isolated from current affairs. The proportion of households watching the news daily is highest for SHS-users but is virtually the same as for grid.

Table 10.4: Percentage of households watching the news

Watch TY news	*SHS-users*	*Grid-users*	*Non-electrified households*
Every day	82%	81%	70%
Sometimes	16%	19%	30%

Table10.5: Household members who watch television most

	SHS-users	*Grid-users*	*Non-electrified households*
Adult men	11%	14%	8%
Adult women	9%	14%	33%
School-going children	43%	38%	38%
All	34%	33%	20%
Adult men and adult women	3%		

These results are interesting in showing that there is little variation in who watches TV across the sub-samples except that children are more likely to be those who watch TV most in SHS households.

10.5 Entertainment

TV and radio are also important sources of entertainment for otherwise isolated households. The majority of all households owning and using a TV watch it daily for close to 4 hours.

Table 10.6: Duration per day of TV watching

	SHS-users	*Grid-users*	*Non-electrified households*
About four hours	75%	95%	91%
One hour	23%	5%	4%
Less than one hour	1%		4%

As can be seen from the Table above, SHS-users are less likely to watch TV for as much as four hours a day. This of course, could mean that their solar system does not permit them to watch for a full four hours.

10.6 Education (extension of times of children's homework)

Another way in which the lives of SHS-users have changed is the possibility of extending the hours of lighting for children's homework..

Table 10.7: Persons in the household studying or doing homework

	SHS-users	*Grid-users*	*Non-electrified households*
Yes	73%	**63%**	
No	27%	**37%**	

Table 10.8: Length of time they study

	SHS-users	*Grid-users*	*Non-electrified households*
Less than an hour	27%	19%	
One or two hours	73%	81%	

Table 10.9: Use of solar light when studying?

	SHS-users
Always	54%
Sometimes	39%
Never	7%

People in most households that have solar or grid lighting have extended the length of time they study: 61% of SHS-users and 72% for grid-users. The majority of those studying use the solar lights. Those adults and children fortunate enough to have solar lights for doing their studying or homework are certainly at an advantage compared with children using candle light or paraffin. More detailed information is required before it can be said that longer hours of study plus better light increases the school grades of the children involved.

10.7 Changes in livelihoods

Changes in livelihoods require observation over long periods of time. Since the concept of livelihoods is vast, it is useful to refer to the work of Villavicencio (2002) who defined what the concept of livelihoods should embrace.

> In the rural world, people are engaged in a number of activities that constitute their livelihoods….The ability to pursue different livelihood strategies is dependent on the basic material and social, tangible and intangible assets that people have in their possession or can access to. The combination of livelihood resources and the pursued strategies is embedded into social structures and patterns of behaviour through which different outcomes are realised. Lastly, livelihoods are framed by the contexts, conditions and trends in which people exist.

The installation of a solar home system is a technological innovation in remote rural areas and for individual households. It has also important social dimensions. Not only does solar lighting make possible the extension of activities in the homestead (Green, 2003), it also changes how the household sees itself, now having electricity, as being recognised.[20]

The question was asked of households "what are the most important changes brought about by the SHS?" Table 10.10 shows the different responses for SHS-users and grid-users.

[20] These aspects are discussed in more detail in the analysis of the follow-up survey in which households who had had their SHS removed expressed their feelings.

Table 10.10: If SHS and electricity changed their lives

	SHS-users	*Grid-users*
Yes	60%	100%
No	40%	

The changes in the lives of those obtaining grid electricity were clearly more marked than for SHS-users.

Table 10.11: Most important changes resulting from solar power and electricity

	SHS-users	*Grid-users*
Security	4%	27%
Bright lights	63%	6%
Buy less fuels	10%	25%
Watch TV	10%	
Listen to radio	6%	
Better living standards	1%	43%
Nothing	7%	

100% of grid-users believe that electricity has changed their lives compared with only 60% of SHS-users who share this view.

SHS-users are much *less* likely than grid-users to say that security is one of the most important changes since they obtained the SHS. A majority agree that having bright lights represents an important change. The percentage stating that less fuels are bought is however, much smaller than for grid households (Table 10.11). For grid-users, by far the biggest change in obtaining grid electricity is an improvement in living standards, a change not endorsed by SHS-users. A small minority of SHS-users claim that nothing at all has changed.

It is possible that not all changes have been for the better. This would be true where the cost of the fee-for-service placed an extra strain on already stretched incomes.

A question was asked of both SHS-users and grid-users: “Are there things the household cannot buy any more”. 15% of SHS-users, despite their higher on average incomes, maintain that there are things they can’t afford to buy since obtaining their SHS. This applies to only 6% of grid households.

Table 10.12: Are there things the household can’t buy any more since obtaining electricity?

Things can’t buy	*SHS-users*	*Grid-users*
Yes	15%	6%
No	85%	94%

Table 10.13: Things households are unable to buy any more

Items	*SHS-users*	*Grid-users*
Food	63%	4%
Transport money	3%	
School fees	3%	
General household needs	31%	

There are quite clear distinctions here between the items SHS-users and grid-users say they can’t afford to buy. Food and general household needs are sited most frequently by SHS-users but rarely mentioned by grid-users.

A useful measure of the perceived change in the lives of households is their response to whether they would advise others to obtain a SHS. 96% of grid-users would advise other to get grid electricity. Only 57% of SHS-users would do so. 43% would not advise others to obtain solar power.

Table 10.14: Would advise others to get a SHS or electricity

	SHS-users	*Grid-users*
Yes	57%	96%
No	43%	4%

10.8 Contributions to job-creation

Most of the operational staff of Eskom-Shell were recruited locally. Although the installers were contracted monthly and paid according to the number of installations completed, this procedure was revised to avoid uncontrolled and sometimes fraudulent installations. 240 installers were used and a few of these remained as technical inspectors maintaining the systems. In May 2001 there were 23 people permanently employed by the company of which 10 were based at the RESCO offices In 2003 at total of 66 persons were employed by the company.

It is common that newly established businesses employ local people when they need them. But whether such firms actually sponsor local economic development is a different matter. Some firms may sponsor local job-creating activities because they expect to have customers with more money to spend. This, however, assumes that such job-creating activities already exist in the community. Though Eskom-Shell clearly has played a role in employing and training local people, it has not moved further in sponsoring other possibilities in job-creation.[21] New jobs could be created by the introduction of water pumping for irrigation systems or lengthening the hours of daylight in farming but it is too soon to detect such changes.

There could in the future be Public Works programmes in the area which could undertake the needed infrastructure improvements, particularly in repairing roads in the remote areas.

Solar energy has not impacted on the high unemployment rate in the area. There is sparse evidence that solar energy has helped the few SHS-users who sell things informally. The texture of life at home may have improved for the unemployed in that they have light, TV and communications, but solar has had, as yet, very little impact on the creation of new jobs in the community.

11. Conclusions and key issues

The conclusions drawn here are those of the first report in a series. A supplementary report to this one carries the results of the follow-up study carried out two years later with the same households. The follow-up study provides more detailed information about what households say about their solar home system. When the SHS has been removed, either for non-payment or because grid electricity is imminent, (as was the case for almost half the sample of Eastern-Shell customers initially interviewed), the comments of households may be even more "honest" and can be placed in a wider context than was possible in the first survey.

The South African SHS fee-for-service model was the first of its kind in South Africa. Part I of this report documented the many obstacles that had to be overcome before SHS units were actually installed in remote rural homesteads. Government policy, the specification of role players, the allocation of responsibility, the legal framework, took time to develop. More than two years were "lost" in the initial phases of the project before the first solar home systems were installed and the field-work undertaken. Field work involved extensive interviews with service providers and their staff followed by interviews with households.

[21] The question of job-creation was discussed at length in a recent interview with the Managing Director of Eskom-Shell. Though the principle is good and has interest for the long term, Eskom-Shell is currently in no position financially to do so.

11.1 The objectives of the research

The objectives of the research were ambitious: they included tracking the developments in what was an innovative government development policy placing solar electricity in rural homesteads which were unlikely to be electrified in the near future. This, the government saw as an answer to the ultimate objective of "electrification for all" The research included measuring the socio-economic impact of SHS on users, detecting resulting changes in fuel-use and in the livelihoods of rural households.

For the newly created service providers, of which there were five including Eskom-Shell, there were even more obstacles to be overcome, lessons to be learned, management strategies and business models to be developed. In the course of time, the restructuring of the organisation and the boosting of the technical training and professionalism of staff also became necessary.

There were also difficulties for service providers to adapt to and impact on the local economic, political and social environment. These are companies that had to engage in frequent and sometimes prolonged contacts with both central and local governments.

Major difficulties arose from the lack of clarity in the government objectives, the procedures for payment of both capital and operational subsidies[22] and the role of solar electrification in the future.

Service providers had to develope a system of tools to handle the delivery and maintenance of SHS, customer accounts, customer queries, and the possibility of breakdowns in what is a relatively new technology[23].

Part 2 of this report dealt with the results of a survey of 348 households. 232 of these were using a SHS, 51 were grid-users living in proximity to the SHS-users and 65 were households who had no access to electricity. These last two sub-samples were "control groups" as a proxy for a truly "before and after" impact study. Analysis of customer responses made it possible to detect important differences between sub samples in terms of income, education, employment, size of dwelling etc. The analysis pointed to the benefits derived from SHSs and the specific grievances of customers.

11.2 Characteristics of households surveyed

The characteristics of the non-grid service areas situated in the poorest parts of the Eastern Cape are an important factor in the overall results of the study.

Though a large majority of rural households are poor, there are wide differences in the total income available to households. There is more heterogeneity in household incomes than was initially thought.

SHS-users are on the whole, wealthier than the sample of grid-households and much wealthier than households without any electricity. The mean monthly income of SHS-users is R2307 compared to R1860 for grid-users and R819 for households with no electricity.

Per capita monthly income is highest for SHS-users: R542 . For grid-users it is R402 and for non-electrified households it is R169 per person per month which is little more than R5 per person per day.

SHS-users are likely to be better educated, have larger homesteads, have fewer household members and are far more likely to be regularly employed. These characteristics are a reflection of the quite strict selection process through which applicants for SHS must pass.

11.3 Installation of the SHS

The installation of SHS for the majority of users was relatively fast, certainly faster than for grid-users waiting for a connection. There is a relatively high level of satisfaction concerning the installation. 72% of households were satisfied and for those who were not, the explanation was that the system was not yet working properly.

[22] Operational subsidies were to be paid through local government but the modalities of payment have still to be worked out

[23] While SHSs have been in widespread use for many years, some components (such as the charge control and metering units) are of recent design.

11.4 Customer satisfaction and ambivalence

Part of Section 5 of the report concerns classic measures of "customer satisfaction" compared with individual questions that permitted households to say what was wrong. Many SHS-users are ambivalent about their solar system as a whole. They are indeed pleased with the 4 lights which come with the system, there are improvements in that they have TV (without having to use a car battery), they have a radio, the children have lights for study, but they are in some senses quite alienated from their system. Customers don't own their system (although 17% think they will in time, be owners of the system). The service provider takes full responsibility for the maintenance of the whole system including replacing light bulbs, which leaves the customer with few ways of getting to know the system or what to report when things go wrong. A large number of customers don't know how to check the credit that is left on their system.

Much of customers' frustration and ambivalence is caused by the impossibility of using their system for cooking. Many had been led to believe that they would be able to cook with their present system or an improved one in the future. Households are still obliged to pay for a variety of other fuels such as paraffin, fuel wood and gas for their cooking needs. Their "burden" here in terms of transport and buying costs has not been reduced. Even for lighting, many households are still obliged to buy candles or other fuels to light rooms where there is no solar light.

Customers are left in ignorance about the subsidies provided by the government. Few are aware of the R3500 capital subsidy. Some are aware of the operational subsidy. That they don't receive it, increases criticism of the cost of the fee-for-service.

11.5 Problems with the solar system

The fact that two thirds of the SHS households interviewed had had problems with the system and that there were delays in getting it repaired dampens the enthusiasm for solar power.

Although 25% of SHS households had never had a problem with their system, 22% had had three or more problems. This underlines the inherent difficulties of maintaining the systems in perfect working order given the local conditions, the low density and the distances which have to be travelled by technicians. Certain of the components appear to be more susceptible to problems than others. All components need testing before being installed with the customer. The card reader is a sophisticated electronic devise which produces much frustration when the card, duely paid for is not accepted by the system.

Three other factors weigh heavily on customers appreciation for the SHS. These are:

- the cost of the token;
- limitations on what appliances can be used;
- the cost of all other fuels that must be purchased, despite having solar power.

11.6 Cost, limited power output and the cost of other necessary fuels

R58 a month is thought to be too expensive by the majority of SHS-users.

When compared with grid households, SHS-users are paying considerably more per kWh and for a much lower voltage than are grid-users.

55% of SHS-users would be willing to pay more for a larger system. The reasons given were that they wanted lights in more rooms and they wanted colour TV.

Many households in fact, had expected to be able to use appliances such as a stove with their solar equipment. 54% own electrical appliances they can't use with the solar system.

11.7 The cost of fuels

All households, whether solar-users, non-electrified or with grid electricity are spending monthly a considerable amount of money on fuels. Only 20% of grid households use electricity for cooking. The dependency on paraffin, wood and gas for all household-needs (such as cooking and water heating) means that large amounts of these fuels have to be purchased.

The analysis in the report has shown the amount each sub-sample is spending per month on their main fuels:

Average monthly spending on candles

SHS-users are spending on average R18 per month, grid-users R9 and non-electrified households R27.

Average monthly spending on paraffin

SHS-users are spending on average R55 per month, grid-users R49 and non-electrified households R51.

Average monthly spending on gas

SHS-users are spending on average R90 per month, grid-users R68 and non-electrified households R69

Average monthly spending on fuel wood

SHS-users are spending on average R102 per month, grid-users R60 and non-electrified households R101

Average monthly spending on dry cell batteries

SHS-users are spending on average R15 per month, grid-users nothing and non-electrified households R29

The average, (mean) spending per month on all fuels, excluding electricity, is highest for SHS-users. They are spending on average R157 per month on all fuels compared with an average of R102 for grid-users and R133 for households without electricity. When electricity is included in the total monthly bill for all fuels, SHS users are paying on average R215 per month compared with R133 per month for grid-users.

The cost of return journeys to buy fuels adds considerably to the cost of the fuel itself. Totalling all journeys per month, this amounts to an average of R156 for SHS-users, R102 for grid-users and R132 for non-electrified households.

There are very large differences in the prices households are paying for all the fuels they buy. Poorer households are penalised for having to buy smaller quantities more frequently.

Households are almost unanimous in the preference for using electricity "should they have the opportunity".

11.8 Changes in fuel-use after receiving solar energy or grid electricity

Most SHS-users state that they are using less fuel – but not fewer fuels – since obtaining the SHS. The percentage of grid-users affirming this is far higher. SHS-users are still obliged to buy candles or use paraffin for lighting rooms where there is no electricity. SHS households use the same amount of fuel for cooking, water heating and ironing as they did before receiving the SHS. There is a strong case to be made that some of these fuels be provided by the service provider.

11.9 Changes in people's lives

The most frequently stated life-changes for households following the installation of a solar system are the use of lights and the possibility of watching TV. 60% of households agree that solar power has changed something in their lives.. Lights and TV are without doubt greatly appreciated. However, these changes are small in comparison with the impact of electricity as expressed by those who now have grid electricity. All (100%) such households say that electricity has changed their lives with 43% stating that their living standards have been improved.

SHS have more contact with the outside world, through the TV and radio, and children have better light for homework, but the real impact of these kind of changes can only be measured over time.

96% of grid households would recommend others to get grid electricity. Only 57% of SHS-users would do so. Indirectly, this measures how the pros and the cons of solar have been weighed and evaluated by the households interviewed.

A concluding remark and perhaps the most serious criticism. As currently delivered, SHS do *not* reach the poorest of the poor. SHS-users are the wealthiest of the three sub- samples interviewed. Those without regular employment, those with little regular income are presently excluded from benefiting from solar electricity.

11.10 Key questions and issues

? Why are customers disappointed? Is it disappointment or frustration or both? It is hoped that answers to this question will emerge in the second phase study. Many SHS-users had been led to believe that they would be able to cook with their system or with an improved system which they understood would be forthcoming. A correction of these misunderstandings is vital.

? Changes brought by innovations such as solar power are small and imperceptible and probably only cumulative in the presence of certain catalysts. Could a service provider - on a bigger scale - delivering not only solar systems but also all fuels required by the household be such a catalyst?

? Households need to feel part of changes in their livelihoods. Presently SHS-users are not encouraged to do so by the fact that they don't own their system – not even after years of paying the service fee. They have even no right to touch the system! Could this be changed in the future? What difference in the opinions of households might come if progressively and over time, they were to acquire ownership of the system?

? Some structure or organisation should be developed which would clearly represent the customers of service providers.

? Customer services provided by the service providers will have to be improved considerably in the future. This will include regularly informing customers of changes and building some kind of incentives for better payment and better care of the systems.

? The "image" of service providers needs to be strengthened. Resco centres and outlets are often almost "invisible" except for the discerning eye. Interiors of these offices are important – even in outlying rural areas.

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A final remark and perhaps the most serious criticism. As currently delivered, SHS do *not* reach the poorest of the poor. SHS-users are the wealthiest of the three sub-samples interviewed. Those without regular employment, those with little regular income are presently excluded from benefiting from solar electricity.

References

Afrane-Okese, Y. and Thom, C. (2001), *Understanding the South African Off-Grid Electrification Programm*e, in ISES 2001 Solar World Congress, Adelaide, Australia, 25-30 November, 2001.

Department of Minerals and Energy [DME] (1998), *White Paper on Energy Policy for Republic of South Africa*, DME, Pretoria.

Hook, W. 2001, *Personal communication*, Solar Vision and Partners, Pretoria.

Kotzé, I.A. (2000) *The South African National Electrification Programme: Past lessons and future prospects*, in *Proceedings of ISES 2000 Utility Initiative for Africa: Rural electrification in Africa*, Midrand, South Africa, 17-18 April 2000.

Banks, D. I. and Karottki, R., (2000), *Energy source for rural communities: power, service and profit*, Energy Resource 2000 Conference.

Barberton, C., (1998), *Restructuring the electricity industry: An analysis of the proposed ownership and governance structures of regional electricity distributors*, Development South Africa, 15 (3).

Barberton, C., (1999), *Exploring the possible impacts of restructuring the electricity supply industry on DSM*, Working document, Energy and Development Research Centre, University of Cape Town.

Barnard, W., (2000). *Personal communication with Dr Wolsey Barnard*, General Manager: Regulation B, National Electricity Regulator.

Covarrubias, A.J. & Reiche, K., (2000), *A case study on exclusive concessions for rural off-grid service in Argentina*, Energy Services and the World's Poor, Energy and Development Report 2000, World Bank/Energy Sector Management Assistance Programme, Washington.

Cowan, W.D., Geerdts, P.C. & Banks, D.I., (1996), *Solar home systems: Techno-economic study*, Energy and Development Research Centre, University of Cape Town.

Davis, M., (1996), *A financial analysis of solar home system dissemination, Annex 15*, in Cowan, W.D., Geerdts, P.C., & Banks, D.I., (1996), Energy and Development Research Centre, University of Cape Town.

Department of Minerals and Energy [DME], (1999a), *Call for proposals on non-grid rural electrification projects*, Sunday Times, South Africa, 29 January.

Department of Minerals and Energy [DME], (1999b), *Documentation on Call for proposals: Non-grid rural electrification projects*, DME, Pretoria.

Department of Minerals and Energy [DME]. (2000), *National Electrification Programme: Policy framework and strategic direction*, DME, Pretoria.

ECON (1999), *A regulatory framework for non-grid electrification*, ECON Centre for Economic Analysis, Oslo.

ERIC 1996. *Meeting South Africa's electricity distribution challenges*. DME, Pretoria.

Gothard, E., (2003), *Nura Household Survey Report*

Hochmuth, F. & Morris, G., (1998), *Evaluation of a PV solar home electrification project in the Free State Province*, in *Proceedings of the Domestic Use of Electrical Energy Conference*, 6-8 April, Cape Technikon, Cape Town.

Jamrani, A., (2000), The Moroccan General Rural Electrification Programme (PERG), in Proceedings of the ISES 2000 Utility Initiative for Africa Seminar: Rural Electrification in Africa, Midrand, South Africa, 17-18 April 2000.

Johnson, C., (2002) *Customer satisfaction study for Eskom-Shell Solar Home Systems in the Eastern Cape Project*, DRA Development, Durban

Kotzé, I.A., (1999), *National electrification programme: Integration of grid and non-grid technologies*, Draft policy, Department of Minerals and Energy, Pretoria.

Martinot, E., Cabraal, A. & Mathur, S., (2000*), World Bank Solar Home Systems Projects: Experiences and Lessons Learned 1993-2000*, April 2000 draft, World Bank, Rural and Renewable Energy Thematic Group and Asia Alternative Energy Programme, Washington D.C.

Mohlakoana,N., (2003) *Needs-based Impact Assessment of Non-grid Rural Electrification: a Case of the Eastern Cape*, Energy & Development Research Centre, University of Cape Town.

Morris, G., (1996), *Structure of the South African photovoltaic industry and markets*, Energy and Development Research Centre, University of Cape Town.

National Electricity Regulator [NER], (1998), *Lighting Up South Africa 1997/1998*, Annual report, NER, Johannesburg.

National Electricity Regulator [NER], (2000), *Regulatory framework for non-grid electrification in the Republic of South Africa*, NER, Johannesburg.

Prasad, K., (1994), *Editorial*, Energy for sustainable development,1(2), July 1994.

Prasad, G., and Ranninger, H, (2003), *The social impact of the basic electricity support tariff*, Domestic use of Energy Conference, Cape Town

African National Congress [ANC], (1994), *The Reconstruction and Development Programme*, Umanyano Publications, Johannesburg.

Thom, C., Annecke, W., and Mavhungu, J., (2000), *Review of South Africa's rural electrification strategy,* Report of the Energy & Development Research Centre, University of Cape Town, South Africa.

Villavicencio, A., (2002), *Sustainable Energy Development: the case of photovoltaic home systems,* Discussion Paper. UNEP Collaborating Centre on Energy and Environment.

Wamukonya, N & Lithole, C., (2001), The South African non-grid programme process, in Proceedings of the African High-level Regional Meeting on Energy and Sustainable Development for the Ninth session of the Commission on Sustainable Development, Nairobi, Kenya, January 2000, pp47-54.