An Evaluation of EnPower in Informally Settled Areas: A Case Study in Okuryangava, Namibia

Erin Dupak
Yvonne Mok
Justin Osgood

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Erin Dupak

Yvonne Mok

Justin Osgood

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Robert Schultz
Renewable Energy and Energy Efficiency Bureau

Approved by:

Professor Creighton Peet

Professor Steve Pierson

ABSTRACT

This report, organized for the Renewable Energy and Energy Efficiency Bureau, addresses the problems created by the inadequate and delayed modern energy plan proposed by *The 20-year Rural Electricity Distribution Master Plan for Namibia.* EnPower, a possible process for developing temporary energy solutions, was implemented in the informal settlement of Okuryangava, Namibia and evaluated for its applicability for Namibia. We have found that the EnPower tools hold significant potential but need further development in order to derive modern energy options without difficulty.

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Roles:

E. Dupak: Erin was often responsible for the group organization. This included encouraging group members to stay on schedule, delegating tasks and preparing for and overseeing meetings and events. In addition, she frequently assumed the responsibility of the being the group's representative. She was also team photographer. Her most notable contribution to the group was her fruit loops and hot pink attitude.

Y. Mok: Yvonne was the main EnPower conductor in managing data entry, data analysis through the EnPower Algorithm software, and basket generation and cost calculation outside of the EnPower Algorithm. She was also responsible for allotting tasks to group members. In addition, Yvonne was the group's chief editor.

J. Osgood: Justin's main contribution to the project involved being the intermediary between the EnPower group and others, including the stakeholders, our liaison, and outside persons. He often assumed the responsibilities of conducting interviews, making phone calls, writing emails and doing errands.

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Executive Summary

There are two billion people in the world living below the poverty line as estimated by Goldemberg and Johansson (1995, p.9). These people live in a constant struggle to obtain basic human needs such as food, shelter, clean water, health services, and waste management. Energy and energy services are key factors in obtaining these basic human needs. The availability of fuels and efficiency of technologies used can greatly affect the level of difficulty faced in providing for these needs (p. 28). Inefficient technologies require more fuel, which could result in higher operating costs for the same or fewer services than more efficient technologies.

In Namibia, ninety per cent of the population relies on traditional fuels such as wood (UNDP, 2002, p. 3). Traditional fuels account for some of the most inefficient energy technologies; wood burned in an open fire only utilizes approximately three to ten per cent of the energy consumed (Batliwala, 1995, p. 31). Expanding the electrical grid to include the entire country would provide modern and efficient energy services to the people of Namibia and may be the optimal solution. Unfortunately, providing electricity connections to the entire nation will take time due to its sparse population, yet vast landmass.

Namibia's Ministry of Mines and Energy (MME) is involved in several energy initiatives including several renewable and off-grid energy programs, but MME's main focus is on expanding the national electrical grid. The *Rural Electricity Distribution Master Plan for Namibia* outlines the entire plan for expanding the national grid. The plan includes a twenty-year schedule outlining when each community will receive an electrical connection. Some settlements in Namibia will not be receiving a connection for another twenty years, while others are not even

included in the plan. With this schedule, many communities have no chance of receiving the social upliftment associated with modern energy services in the foreseeable future.

The EnPower Toolkit may be able to provide communities in Namibia awaiting electrification, with an intermediate solution to their energy needs. EnPower outlines the procedures and provides the tools for conducting an energy audit of an area and uses the information obtained to produce viable options for modern energy services, or "baskets." A basket includes all the fuels and appliances to meet the energy needs of the households in the community. EnPower is a new concept that is still in the development phase but shows great potential as a tool for providing energy upliftment (*EnPower First Field Trial Report*, 2002, pp. 1-2). EnPower has been tested in the rural community of Okamapuku, Namibia, and was considered successful. Though the success at Okamapuku is promising, it does not indicate how EnPower will perform in different types of Namibian communities such as informally settled areas.

Our goal was to use and evaluate the EnPower process in order to develop recommendations and comments about its applicability to the informally settled areas of Namibia. To evaluate the EnPower process, there were two main objectives that we needed to achieve: to obtain a thorough understanding of the EnPower project; and to synthesize suggestions to improve the EnPower process to be more suitable for Namibia's informally settled areas.

In order to better structure our analysis and reduce biased judgment, we developed a set of guidelines prior to implementation. These guidelines included three conditions, the completion of EnPower's seven objectives, each individual step of the process was completed satisfactorily, and the overall process was completed satisfactorily. These guidelines included criteria that were developed in order to verify that each of the stated conditions was met. Indicators were subsequently developed to aid in determining if each criterion had been achieved. These criteria took into account the overall desired outcome of the condition, the completeness of the condition, the ease of achieving the condition, and the requirements demanded by the condition.

In preparation for implementing the EnPower Toolkit, we examined the EnPower process, and made subsequent modifications to areas of the process that we felt could be improved. These changes ranged from small changes in the wording of survey questions to the introduction of a paired comparison process. Once this was completed, we tested the entire toolkit with our modifications in the informally settled area of Okuryangava, located north of Windhoek.

We surveyed 36 households, and from these interviews we were able to gain information on monthly income as well as fuel usage and expenditures. The average household income in our sample was reported to be approximately N$1100 a month, which we used to establish the division between low and medium income brackets. It was later verified during a meeting with stakeholders that this figure might actually be closer to N$750 a month.

To assess energy usage in the community we considered both the types of appliances used and the amount of time each household spent doing various fuel consuming activities. From these data we were able to determine the amount of energy consumed and therefore the fuel used. The data on fuel usage could then be used with information on fuel costs, also collected during the survey, in order to calculate expenditures. Once we gathered all the information regarding energy supply, usage and preference in the community, we were ready to enter it into the EnPower software tools and generate baskets.

The output of this process was ten baskets, six for the low-income households and four for the medium-income households. Of the six baskets generated for the low-income bracket, the first three included lighting, radio and cooking services, while the second set of three contained refrigeration in addition to these services. Also, half of the low-income baskets offered a limited electric grid connection, whereas only one of the four middle-income baskets offered electricity. Although this may seem contradictory, the other three middle-income baskets incorporated complementary forms of modern energy equipment like solar-energy home systems. It is interesting to note that the more expensive baskets tended to be a better investment with high initial costs but provided savings in the long term with lower life cycle costs.

With basket generation complete we met with relevant stakeholders in order to present them with our findings and facilitate a discussion about possible energy solutions for the community. The information presented during this meeting specifically focused on information gained during our data gathering phase and the baskets generated based upon these data. One of the goals of the meeting was to inform stakeholders and obtain their feedback on both the data collected and the different baskets generated. Overall the meeting was a success, even though no plan of action was determined. Even without producing an immediate solution, EnPower has begun a dialog generating ideas for future development in the area and may still be able to provide a solution.

Those that attended the meeting generally thought the EnPower process was a good idea, but that it would be more effective for Windhoek if it was combined with an existing feasibility study or done in conjunction with a low-cost housing project. The EnPower process was regarded by stakeholders as a “qualified” success, but it still needed improvement. It was recognized that EnPower is only one piece of the social upliftment puzzle and would most likely work best in conjunction with socio-economic development projects.

Looking at the overall implementation we found that EnPower was successful, but the process contained areas that needed improvement. One such area was the EnPower Algorithm, which produced illogical numbers in regards to cost figures for the baskets that were generated with no explanation as to their origin. As a result many of the data that were supposed to be presented to the stakeholders had to be calculated manually, consuming unnecessary amounts of time. Other issues were of lesser significance but affected the overall process and should be addressed by further refinement of the EnPower Toolkit. Some of these issues include defects within the Data Collation Tool and issues surrounding the ability to collect accurate data.

Overall we believe the concept of providing a community with complete energy solutions is ambitious but may be the most appropriate answer. This approach brings together all the various fuels and appliances a household would need, thereby simplifying the selection process. The basket concept also gives outside stakeholders, such as a municipality or energy service provider, a single package to offer that addresses all household energy needs, allowing them to simplify delivery. The EnPower process also provides the community with the opportunity for involvement by allowing community members to select from baskets that have been tailored to their needs. By allowing the community a voice in the final selection, the chances that they will accept the final product are increased.

Although the EnPower concept seems to be an appropriate answer to the problem of providing modern energy services to poor peri-urban and rural communities, we recommend that the tools and procedures included in the toolkit be further developed. Further tests should be focused on developing the software and fine-tuning the process as well as proving the validity of the EnPower concept. Proving the validity of the EnPower process would require an analysis of the basket implementation as well as follow-up research in an area following the completion of the EnPower process. If the EnPower Toolkit can be further refined and its validity proven, it will be able to serve as a standard for providing intermediate energy solutions to communities in need.

1 Introduction

A vast majority of the people living in the less developed countries of the world aspire to improve their sub-standard living conditions (Goldemberg & Johansson, 1995, p. 9). For these people, an improved standard of living means being able to obtain basic human needs. These basic needs include food, shelter, health services, clean water, access to education and employment, and waste management. Energy is an important element in providing for basic needs. More importantly, the services provided by modern energy can greatly improve the living conditions of the poor. For example, using electricity in order to cook food is more efficient as well as healthier than using wood burned in an open fire. Unfortunately, more than two billion people in the world do not have access to modern energy services (DFID, 2003, p. 1). These people's lack of knowledge in how to acquire modern energy sources and/or the inability to pay for these energy services, combined with the inability of national energy utility companies to provide such services to everyone, prevent the people from obtaining modern energy. Those without modern energy sources rely on traditional fuels such as wood, animal dung, and waste materials to cook food and heat their homes. The methods of traditional fuel usage have many implications. For example, the burning of wood, animal dung, and waste materials in open fires has many health and safety concerns, such as the inhalation of large amounts of particulate matter and/or toxic emissions. Also, the collection of wood has many costs, such as human labor hours that could otherwise be spent on income-generating activities, as well as environmental costs, such as deforestation. If the poor of developing countries could be provided with modern energy and modern energy services, these costs could be reduced and living standards could be upgraded.

In Namibia, there are many rural areas and peri-urban areas that do not have service from the national electricity grid. Nationwide, ninety per cent of the people rely on traditional fuels such as wood (UNDP, 2002, p. 3). In comparison, less than eleven percent of the world uses traditional biomass (Goldemberg & Johansson, 1995, p. 9). Providing Namibia with complete grid-electrification is difficult due to its large landmass and sparse population. Also, it is difficult for NamPower, Namibia's electricity provider, to maintain electricity capacity for the urban and peri-urban areas because the rapid growth of the informally settled areas is outpacing NamPower's ability to provide the needed power. Because Namibia, a young country, is still developing its infrastructure and services, there is much planning and work that needs to be done.

The Ministry of Mines and Energy (MME) of Namibia has several initiatives to expand the electricity grid to rural and peri-urban regions. The *White Paper for Energy* was written in 1998 by the MME as a national energy policy to achieve the security of energy supplies, social upliftment, energy investment and growth, and economic efficiency and sustainability (MME, 1998, p. v). The *White Paper* led to policies on renewable energy and the electrification of the nation. The policies regarding renewable energy focused on wind, solar and biomass energy. The *Rural Electricity Distribution Master Plan for Namibia* is the policy document that addresses issues regarding the systematic electrification of the nation. The plan, however, involves a twenty-year schedule, leaving many rural and peri-urban regions of Namibia without electricity for years to come, while some areas are not scheduled to receive service at all. The people of these areas have no immediate solution to improve their sub-standard living conditions.

The EnPower project is a possible intermediate solution to the *Rural Electricity Distribution Master Plan*'s scheduling gap. Developed by the United Kingdom's Department for International Development (DFID), EnPower is a process and tool that can "'facilitate' the selection and decision as to what mix of modern fuels and appliances should be offered to a rural [or any off-grid] community" (EnPower Project, 2003, p. 1). Currently the Renewable Energy and Energy Efficiency (R-3-E) Bureau is considering the benefits of the EnPower project and the possible positive outcomes that can be provided to the communities of Namibia. The EnPower project is a complete package of data gathering and data analysis tools that produces suggestions for different energy service combinations that a community may choose. EnPower has already been implemented in the Msinga District of Kwa-Zulu Natal, South Africa, and in Andiyarpalayam, India.

Before one can apply the EnPower process to the communities of Namibia, it needs to be thoroughly tested and customized to the various communities. One rural community, Okamapuku, Namibia, has already served as a trial case. However, there are many different communities in Namibia, such as the informally settled areas (ISA's), that also do not have access to the national electricity grid. Having implementation data from the different Namibian communities is necessary in viewing the applicability of the EnPower process to Namibia as a whole.

Our goal was to use and evaluate the EnPower process and develop recommendations and comments about its applicability to the communities of Namibia. In order to evaluate the EnPower process, there were several objectives that we needed to achieve, which included: knowing the criteria for an appropriate energy assessment and analysis process for Namibia and how to measure them; obtaining a thorough understanding of the EnPower project; and synthesizing suggestions to improve the EnPower process to be more suitable for Namibia's communities. The necessary evaluative criteria will be developed according to the needs of Namibian communities as well as the user's needs for implementing EnPower. In order to understand the EnPower process, it is necessary for us to complete the implementation as detailed by the EnPower Toolkit. The suggestions to improve EnPower will be derived from examining the implementation based on the criteria we originally developed, along with any additional criteria developed during the implementation. With our evaluation and recommendations, we hope to discover whether EnPower will provide viable intermediate energy solutions to the poor communities of Namibia while they wait for electrification.

2 Background

Informally settled areas or squatter settlements are some of the poorest and most underprivileged areas of Namibia. The people living in these areas struggle to obtain their basic needs. If they could obtain modern energy services they would be able to substantially increase their standard of living. However, many have neither the knowledge nor the resources to improve their situation. As a result, the first step in helping these people to improve their lives is providing them with options for modern energy services. This chapter will more closely explore the situations of these poverty stricken areas, and examine the strategies already taken in order to remedy the situation. By identifying the Government of the Republic of Namibia's (GRN) strategies for providing its people with modern energy we will be better able to identify what the country's leaders are trying to do and what still needs to be accomplished. One of the specific areas of need that has already been identified involves off-grid energy assistance. The EnPower Toolkit was developed to aid in making assessments of the off-grid energy needs of poor people and generating possible solutions for meeting their needs.

2.1 Informally Settled Areas

Informally Settled Areas (ISAs) are found in developing countries throughout the world (Fadare & Mills-Tetty, 1992, pp. 71-72). They occur when the demand for housing becomes greater than what the "formal economic sector" (p. 72) can handle. This is a problem that the city of Windhoek is facing; there are currently several ISAs in the outer reaches of the city. The people living in ISAs are poor and cannot obtain modern energy services. This is one reason the standard of living of the people in these areas is far below what is considered acceptable by much of the world. There are both government agencies and Non-Governmental Organizations (NGOs) interested in helping improve these sub-standard living conditions, but they often lack the information needed to make their support effective.

On the surface, an informally settled area appears to be a chaotic mixture of shacks made from scraps of metal, wood, and fabric. Plots of land are seemingly claimed at random and do not follow any legal demarcations. Underneath this chaotic appearance, however, is a social and economic structure that is similar to almost any community. Within Namibian ISAs, shebeens, or informal bars, help to provide social and cultural gathering places as well as contribute to the local economy. They can be places for people to congregate, and many shebeens offer entertainment in a variety of forms, such as a radio, television, or billiards. Shebeens also serve as local stores selling basic supplies such as candles, paraffin, soap, and food. Churches can also provide a social and cultural structure to the community. The residents of ISAs sometimes organize informal churches that congregate outside for services, or in shacks built for these services. There are also many kinship connections within ISAs due to extended families tending to live, if not in the same household, then in nearby shacks (Vicar Cloete, personal communication, March 19, 2003).

Informally settled areas are formed on public land that has been left unoccupied and is often located near employment opportunities (Fadare, Mills-Tetty, 1992, pp. 71-79). The ISA occupants have no legal claim to the land and are therefore not allowed to make substantial upgrades to their homes like acquiring utilities such as clean water or electrical connections

(Schultz, private communication, March 19, 2003). Since most of these areas are without an electrical grid connection, the residents rely heavily on traditional fuels and alternative energy sources to meet their energy needs. Some of the traditional fuels used can pose health risks to the occupants of these communities as is discussed later in this chapter.

There are organizations that are interested in helping the ISAs of Namibia in acquiring modern energy services and improving their standard of living. Unfortunately, since ISAs lack a formal structure, it is hard for outside groups to provide them assistance. One of the obstacles is a lack of information, especially information on a specific area that would be necessary for providing appropriate solutions to that area. The information that is available on how energy is obtained and used in these informal areas is limited and incomplete.

From the information that is known, it is apparent that wood fuel is a major source of energy for Namibians, and it is used extensively in informal settlements for cooking, lighting and heating purposes (Renewable Energy and Energy Efficiency Bureau [R-3-E], 2002, p. 1). Open fires provide a place that groups often gather around at night because they provide light (Vicar Cloete, personal communication, March 19, 2003). The Gowaseb Evangelical Lutheran Church Choir in Babilon, Namibia, for example, practices around a fire to provide light for reading their songbooks. In rural areas of Namibia, firewood collection is still viable, because deforestation caused by firewood harvesting has not been as severe as in the peri-urban areas. In the more densely populated informal settlements, such as Okuryangava, wood is no longer easy to collect, so it must be purchased. Due to the high levels of unemployment in ISAs many households do not have enough steady income to purchase firewood regularly.

Though firewood accounts for a large portion of the energy consumption in informal settlements, it is not the only source of available energy. Within Namibian ISAs candles, paraffin, and Liquid Petroleum Gas (LPG) lanterns are used for lighting. Paraffin and LPG can also be used to fuel stoves for cooking. Solar panels do exist in these ISAs though they are too expensive for most people to buy and represent the exception rather than the rule. Diesel generators are another energy source available in Namibia, but like solar panels, they are rare in ISAs due to their cost. There are also sometimes illegal connections made from the national electrical grid, though the prevalence of this varies from one area to the next. For example, in one ISA near the town of Okahandja, approximately thirty-six percent of the households have illegal connections (Austin Cate, personal communication, April 4, 2003), whereas in the Okuryangava district near Windhoek there are few illegal connections, and they are mostly found in shebeens.

Informally settled areas are some of the poorest communities in the world and often have hazardous living conditions. Reliance on traditional fuels can result in health problems and hazardous conditions for the people using them. Toilet facilities are shared by the entire community and are often primitive creating unsanitary conditions (Fadare, 1992, pp. 71-79). Homes are small and often consist of only one room that is shared by an entire family. These crowded and often unsanitary conditions allow diseases to spread quickly.

2.2 Energy to Improve Living Conditions

Many experts, such as Goldemberg & Johannson (1995, p. 11), Suarez (1995, p. 18), and Batliwala (1995, p. 32), agree that modern energy and energy services are important in order to improve sub-standard living conditions In the informally settled areas of Namibia, found in the rural and peri-urban regions, many households are without modern energy connections, such as electricity. In order to understand how energy is an important element in improving living conditions, one must first understand the effects of sub-standard living conditions and what roles modern energy and energy services can play in improving living conditions.

2.2.1 Sub-standard living conditions

The informally settled areas and rural areas of Namibia have higher concentrations of poverty than other regions of the country and usually consist of inhabitants who live in sub-standard conditions (Fadare & Mills-Tetty, 1992, pp. 71-79). While these sub-standard conditions involve the lack of access to basic human needs such as food and clean water, the unavailability of modern energy primarily affects people's health and quality of life

Maintaining good health through proper health maintenance and healthcare services is difficult for those who struggle to meet their basic needs. The poor living in informally settled areas are faced with limited access to health facilities because they are either unable to pay for services or there are no facilities located within easy traveling distance to treat illnesses that require immediate attention. Other health concerns of the inhabitants in informally settled areas involve food preparation and storage. The unavailability of modern energy and energy services, like refrigeration, makes it difficult to prevent food from spoiling. Due to conditions of poverty conserving as much food as possible is important and, it may be the case that spoilt food is eaten even though it may be unhealthy.

In addition to problems with food storage, food preparation is another issue that greatly affects the poor. As mentioned in Section 1, many of those without modern energy use traditional fuels and methods for cooking and heating water, such as burning wood and waste materials. However, this method is extremely inefficient, using only three to ten percent of the potential energy in the available fuel and consuming more fuel than necessary to prepare a meal (Batliwala, 1995, p. 31). If the fuel is in short supply, and the cooking method is inefficient, it may not be possible to cook food thoroughly, which can cause health problems. Also, burning materials release large amounts of particulate matter that are harmful upon inhalation. In particular, burning waste, such as animal dung, releases high toxic emissions such as TSP, benso-a-pyrene, carbon monoxide, and polycyclic organic pollutants. In less developed countries, women and children often spend most of their day around the fire and therefore are most affected by the harmful emissions. Women, in particular, are exposed the most to the toxic emissions because they start cooking at an early age and continue with the food preparation tasks for the rest of their lives (p. 30). Besides the harmful emissions associated with burning wood and wastes, the collection of such fuels can affect a person's physical health. Depending upon the availability of traditional fuels, such as wood, some people have to travel long distances to collect or purchase fuel, which can be physically strenuous. Unnecessary and excessive hard labor can overstress the body, causing further deterioration in the health conditions of the poor.

In addition to impacting people's health, the absence of modern energy can affect the quality of life that people have. One of the considerations for improving the quality of life involves conserving time in doing daily activities so that more time can be spent on other activities. Using traditional fuels to prepare food may consume more time than using modern energy. Also, collecting or traveling to purchase traditional fuels may consume excessive amounts of time. The amount of time that is consumed on these activities could be better spent on generating income, looking for employment, or studying in order to obtain higher-paying jobs. Besides considerations of time, the ability to engage in any activities after sunset is difficult if lighting is inadequate. Nighttime activities include social gatherings as well as studying time for students.

2.2.2 Modern energy's role

With a clearer understanding of the sub-standard living conditions that many informally settled areas face, one can see the justification for improving those conditions. Goldemberg and Johansson (1995, p. 9) indicate that in order to elevate sub-standard living conditions, basic human needs must be satisfied. These needs include access to jobs, food, health services, education, proper housing, clean water, and sewage management. More importantly, the services that energy can provide are more important than the energy source itself. In order to better understand modern energy's role in improving sub-standard living conditions, examples of the different areas of available services will provide a clearer picture. The different areas that will be discussed include health care, safety, education and employment, and convenience and efficiency of completing tasks.

The poor health conditions previously described could be uplifted if modern energy were available. For example, refrigeration can increase the shelf life of food as well as medication in health clinics. Modern energy could also provide lights for health clinics, so that operating hours could extend after sunset. The health risks of using traditional fuels, as mentioned above, can be reduced with modern energy. More specifically, the emissions released from burning materials can be avoided as well as the physical labor involved in collecting such fuels. In addition to the above-mentioned examples, the availability of modern energy could provide indoor space heating during the cold winter months. In some areas, the absence of adequate heating could lead to extremely cold conditions that could cause health problems.

Another issue that modern energy can address is related to safety situations. In areas of poverty, crime can be an issue, particularly at night. If outdoor lighting could be provided, the amount of crime could be reduced. A different kind of safety situation involves the usage of fuels. Fuels, or appliances that use fuels, such as candles, gas, and paraffin have a greater potential of starting fires compared to modern energy, such as electricity. Open fires are another safety hazard that can be avoided with modern energy. For example, an electric stove poses less of a threat than an open fire into which a child could fall and become severely burned. There are dangers with modern energy as well, such as electrocution due to poorly and illegally wired households. However, these risks can be greatly reduced if modern energy could be provided legally and with proper safety measures.

Beyond health and safety concerns, modern energy has many other benefits related to education and employment opportunities. For example, modern energy, more specifically electricity, can provide light after sunset enabling students to study. Lights provided by electricity can also allow teachers to instruct students on days when insufficient sunlight cannot illuminate classrooms. Modern energy can also provide business opportunities for the poor. Some residents of informally settled areas own shebeens that could attract more business if lights and other equipment could be used to expand services available at these local gathering places.

Undoubtedly, modern energy can be applied in many areas in order to improve the lives of the poor, including greater convenience and timesavings. Modern energy can improve the efficiency of doing many household tasks, including cooking, ironing clothes, bathing, and cleaning. The time that can be saved could then be applied towards employment and education. Also, modern energy has the benefit of being versatile. For example, where paraffin could only serve for lighting and cooking, electricity can additionally provide cleaning, entertainment, and sewing services. Modern energy also provides greater convenience. For example, if a mother needs to attend to a crying baby at night, being able to easily 'turn-on' a light is more convenient and safer than trying to finding matches and lighting a paraffin lamp or candle.

The examples given above are only a small fraction of the possible services that modern energy can provide. After understanding what sub-standard living conditions entail and seeing a glimpse of the possibilities modern energy offers, it is then necessary to find ways to provide the modern energy services to the poor.

2.3 Energy Policies in Namibia

Recognizing the need to improve a community's standard of living by providing modern energy services, the Ministry of Mines and Energy (MME), Namibia's government agency charged with managing the country's energy and natural resources, issued the *White Paper on Energy* in 1998 (MME, 1998). *White Paper on Energy* is a national energy blueprint for developing the country's energy and it laid the groundwork for a number of modern energy policies that have since guided this young country's energy plan. Those policies fall into two categories, electrification and renewable energy.

2.3.1 Electrification Policy

The *White Paper on Energy* led to plans for the electrification of Namibia. After gaining independence on March 21, 1990, Namibia's Ministry of Mines and Energy started a national rural electrification program, termed *The Rural Electricity Distribution Master Plan for Namibia*, in collaboration with Namibia's leading energy provider, NamPower (MME, 2000). The purpose of the master plan is concisely stated in its objective:

> provid[ing] guidelines and establish[ing] priorities for the upgrading and extensions of the existing electrical distribution networks in Namibia which will enable NamPower in conjunction with the Ministry of Mines and Energy to establish the networks to meet the demands of development in an orderly and cost effective manner (vol. 1, p. 1)

In short, *The Rural Electricity Distribution Master Plan for Namibia* hopes to identify the objectives and methods on how to achieve the electrification of Namibia.

To set about obtaining its goals, *The Rural Electricity Distribution Master Plan for Namibia* incorporates the locations and population densities of all 13 regions in Namibia. The plan also encourages stakeholders to contribute to the prioritization process of where and when to electrify (MME, 2000, vol. 1, p. 1). While the plan considers both grid and off-grid electrification options, it financially emphasizes grid electrification more than off-grid electrification, allocating N$46 million and N$5 million a year to each, respectively. With additional funds, the electrification process may be expedited and as changes are made in funding availability and in community needs, this plan will be reviewed and reorganized accordingly.

Thirteen of the sixteen volumes of *The Rural Electricity Distribution Master Plan for Namibia* are designated to each of Namibia's regions (MME, 2000, vol. 1, p. 2). The other three volumes cover the National Overview Report, the Financial & Economic Analysis Report and the Master Planning Approach & Methodology Report (vol. 1, p. 2). Each of the regional reports can be considered separately, but to gain a national perspective it is imperative to consider all 16 volumes. Each of these reports consists of six sections individually addressing topics on the profile of the region: its rural electricity distribution master planning; its network planning; background on off-grid electricity and an introduction to the applications of an off-grid program; a cost analysis; and the implementation aspects of rural electrification in the region.

Due to the high-energy demands in Namibia's urban centers, *The Rural Electricity Distribution Master Plan for Namibia*, and subsequently NamPower, first focused on these highly populated areas, located in the northern part of the country, and proceeded to rotate clockwise through the country in the electrification process (MME, 2000, vol. 1, p. 1). To date, most of the large rural areas and some of the smaller areas in all 13 regions of Namibia have been electrified, and it was projected that within the first ten years 33,843 new connections will have been made (vol. 1, p. 53).

Once those urban areas were electrified, NamPower and MME shifted their focus to rural areas. Currently, they are targeting substantially smaller and more remote settlements and farms throughout the country (MME, 2000, vol. 1, p. 1). NamPower's inability to immediately grid-electrify the entire nation has resulted in the development of a small off-grid energy sector (vol. 1, p. 36). Currently there are 2,855 rural settlements in Namibia, 2,486 of which are not connected to the national electricity grid (vol. 1, pp. 10, 23). Due to some of these settlements' propinquity to the grid, 2,355 of them have the potential to be grid-electrified, leaving only 131 settlements to rely on off-grid or stand-alone electricity generating technologies. For the 2,355 settlements that have the potential to be grid-connected, the 20-year master plan will determine when they will be connected. Some of these settlements are located in *off-grid areas*, which are defined as "clusters of non-electrified localities that are not prioritized for grid electrification within the first five years of the grid electrification plan" (vol. 1, p. 37).

The Khomas Region, in which Okahandja Park and Ongulumbashe are situated, illustrates the immensity of the electrification process. Encompassing Windhoek Rural and Windhoek Urban, more specifically the cities of Windhoek and Dordabis, it is the most populated region in Namibia, covering an area of 36,805 km^2 (MME, 2000, vol. 7. p. 5). Based on the 2001 Population and Housing Census, twelve percent of all Namibians live in these two cities and eighty-nine percent of the population in the Khomas Region lives in the Windhoek Urban section (March 2002, pp. 12-13, 30-31). By contrast, Windhoek Rural covers eighty-nine percent of the region's land area. Overall, even though most of the land is rural, most of the population resides in urban areas. Of the N$1 trillion allocated to the entire 20-year plan, the Khomas Region will receive only N$8.4 million (MME, 2000, vol. 1, p.55). While this figure is substantial, it pales in comparison to the amounts given to other regions mainly because the Khomas Region already has excellent electricity coverage. This assumption seems logical based upon the fact that only 457 grid connections are planned over the next 20 years. Averaging about 25 connections per year, the plan anticipates offering only 421 household connections, 7 school connections, 1 health clinic connection, 22 borehole connections, 3 church connections, and 3 shop/office connections (vol. 1, p. 96).

The Khomas Region is broken down into 26 developing and rural settlements, of which 16 are not electrified (MME, 2000, vol. 7, p. 6). Each of these communities varies in size and contains up to 62 houses. Within the region, there are eight un-electrified schools, one un-electrified health clinic and two un-electrified NamWater offices. The *Rural Electricity Distribution Master Plan for Namibia* has been employed in the Khomas Region to help remedy the poor living conditions found in areas similar to Okahandja Park and Ongulumbashe, and according to the plan, 13 of the 16 named settlements will be connected to the grid within the next 20 years.

This 20-year plan addresses the demand for modern energy services; however, it does not do so in an acceptable time frame. People are in immediate need of modern energy, and they do not have the luxury to wait 15-20 years for a grid connection. To alleviate this immediate, yet transitory energy demand, the government has looked into using alternate energy sources for obtaining modern energy, more specifically renewable energy.

2.3.2 Renewable Energy Policies

To address the modern energy needs of Namibians who are either awaiting connection to the national grid or are not scheduled for grid connection at all, the Ministry of Mines and Energy and municipal groups developed renewable energy policies. The policies on renewable energies are separated into three individual policies focusing on solar, wind, and biomass. Of the three preliminary studies on these three sources, solar power proves to be the most successful, wind the least and research on biomass is still in progress. It is also interesting to note that the biomass energy policy was developed under the direction of the Renewable Energy and Energy Efficiency Bureau (R-3-E), the sponsor of our project.

HomePower is the largest of three policies focusing on solar power. The policy was developed in 1996 by the Namibia Development Corporation (NDC) in conjunction with Premier Electric, to provide solar electricity to off-grid households (MME, 2000, vol. 1 p. 49). *HomePower* was allocated N$13 million over an eight-year period and planned to offer a variety of solar home systems (SHS) ranging from 50 to 350 watts of available power (Hipangelwa, 2003, pp. 1-6). Associated with each solar home system was a different type of payment plan. As of December 2002, 600 systems had been installed, and, surprisingly, only ten have been reported stolen. The other two projects, titled the *Lianshulu and Spitzkoppe Project* and the *AccuPower Project*, were implemented by MME in 1999 and 2000, respectively, and together totaled slightly over N$4 million. The results of both projects are not yet known because they are still in the test phase.

Another renewable energy source is wind energy. In 1993, MME launched a program called the *Promotion of the Use of Renewable Energy Sources in Namibia*, in which wind energy was a primary focus (AEA Technologies, 2003). Two measurement stations were set up in Walvis Bay and Lüderitz, and a final report was published in 1997 compiling the results of the study. It concluded that wind energy is a viable energy source in Namibia, but it is not yet economically feasible. Based upon this report, Namibian stakeholders offered their support towards the further development of wind energy “provided that the international donor community would make available the additional financial support required to make the project economically and financially viable” (2003).

The third natural resource that MME has focused on is biomass. The National Steering Committee (NSC) on Biomass Energy was formed by the National Energy Council in 1998 under the advice of the Program for Biomass Energy Conservation in Southern Africa (ProBEC) (Renewable Energy and Energy Efficiency Bureau [R-3-E], 2002). The NSC was created to oversee the creation of a *National Biomass Energy Strategy*. The strategy's aim is to utilize the energy found in biomass, which involves improvements in the methods of obtaining energy so that the process is more efficient.

The Renewable Energy and Energy Efficiency Bureau (R-3-E), a member of NSC, is currently involved in a comprehensive project with MME in order to produce this *National Biomass Energy Strategy*. This project has already done extensive work toward an assessment of available technology by examining the energy options available from biomass in Namibia. Work has also been done to implement two pilot projects, one on fuel-efficient stoves and one on wood gasification (R3E final report, 2003, phase I and II). These projects have shown promising success and show that a realistic biomass policy can be successfully implemented. The Renewable Energy and Energy Efficiency Bureau is now working on developing a key issues report and a Geographical Information System management tool. The key issues report will include all relevant concerns regarding the consequences of using biomass as an energy source. The Geographical Information System management tool will allow for a graphical representation of all the data collected in the study along with any other national satellite data collected, including meteorological data, energy deployment, and population density. This Geographical Information System management tool will assist in the creation of a *National Biomass Energy Strategy* and aid in its analysis and management in the future.

Although these plans address the issue of inadequate energy services in semi-urban areas like Okahandja Park and Ongulumbashe, they do not do so in a timely manner. Based on the latest copy of the *Rural Electricity Distribution Master Plan for Namibia*, some settlements are not scheduled to receive electricity off the national grid until the year 2018. This proves to be a problem when it is evident that these settlements need immediate modern energy and the services that modern energy provides to help them improve their standard of living.

2.4 EnPower

To address the time gap between the present and when people will receive power from the national grid, MME and NamPower are trying to find an intermediate solution to provide the off-grid regions with modern energy. The EnPower Toolkit, which encompasses a process and software program for conducting an energy audit, may prove to be a viable solution to this time gap issue. EnPower is a new concept and is in the process of being developed. It has been tested in several locations, including one location in Namibia. These tests have provided useful information and led to many improvements in the Toolkit. We have contributed to further refinements by conducting an additional test in Namibia, but first the steps of the process and the tools involved need to be understood.

2.4.1 EnPower Background

Before examining the process and tools that comprise the EnPower Toolkit it is essential to understand its purpose and the history behind its development. The EnPower Toolkit standardizes the process for conducting an energy audit in a community, which examines the energy usage and requirements of a community (EnPower Toolkit Overview, 2003, pp.1-5). EnPower also provides steps for developing options for the community to increase its energy services. By standardizing the auditing process and combining it with the resources to develop alternative solutions, EnPower hopes to aid in providing communities with energy assistance.

EnPower's purpose is to address the need for a procedure to develop off-grid energy solutions in un-electrified communities (EnPower Toolkit Overview, 2003, pp.1-5). The EnPower process identifies appropriate and complete energy packages that may be offered to individual communities based upon individual income, available fuels and appliances, and desired energy services. These packages, termed "baskets," include the fuel, the appliance to be used and the service that will be available to the user. For example, a basket might include a battery (fuel), a radio (appliance) and musical entertainment and communication (service).

EnPower provides these various complete energy packages in order to simplify the selection process for people who may have no prior knowledge of alternative energy services, as is often the case among people from poor and rural areas (EnPower Toolkit Overview, 2003, pp.1-5). There are many government agencies and non-governmental organizations that are interested in helping to provide energy upliftment to these people. While these organizations have the necessary knowledge of alternative energy options, they lack the in-depth knowledge of the people's situation to make decisions for them. EnPower provides a tool to investigate the situation in a community and synthesize these data with information on the available alternatives combined with support from external stakeholders.

The benefits associated with the EnPower Toolkit include developing a practical computer model that identifies the energy needs of those living in poor communities (EnPower Toolkit Overview, 2003, pp.1-5). The process also facilitates community level empowerment through informed decision-making about different energy options and their availability to the community. The EnPower process can result in affordable and appropriate modern energy interventions, leading to an increased standard of living for those in the community.

The EnPower concept originated five years ago with Paul Harris of Integrated Energy Solutions (IES), but the EnPower Toolkit began to take shape two years later. At that time, it received funding from the United Kingdom's Department for International Development (DFID) on the condition that IES obtain international partners for the project (Integrated Energy Solutions, 2003). AEA Technology Environment from the United Kingdom, and Energy, Economy, and Environmental Consultants (3-E-C) of India soon became those international partners required by DFID.

The EnPower Toolkit has since been tested at three sites, the villages of Iphuphuma & Gordon Memorial in Kwa-Zulu Natal, South Africa; Andiyarpalayam, India; and Okamapuku, Namibia. During these three tests the process was refined and became progressively more efficient with each implementation. The data from these test sites is available, and some of the information from Okamapuku, such as the Supply-Side Research, can be recycled for our implementation. Both the South African and Namibian sites were rural and had no connection to an electrical grid, but the site in India was more densely populated and approximately eighty percent of the households were connected to an electrical grid. The first test was conducted in the villages of Iphuphuma & Gordon Memorial in South Africa and tested the validity of the EnPower concept as well as helped debug the toolkit (*EnPower First Field Trial Report*, 2002, p. 1). After completion of the study, the findings and observations were noted. One of the observations noted was that the researcher needs to be aware of the time required to engage with a community and that the process cannot be rushed (2002, p. 2). Another remark stated was that it is important to identify who has power in a community, while still including all persons in debates and discussions. An observation on the management of expectations was also mentioned and said that it could also be problematic.

2.4.2 The EnPower Toolkit

The EnPower Toolkit outlines five sequential phases and provides the tools for completing the EnPower Process. The five sequential phases that are to be completed are: Initialization; Situational Analysis; Detailed Investigation and Data Gathering; Calculation and Basket Development; and Presentation to Stakeholders. The first two phases are meant to set up the project and familiarize implementing parties with the area. The third and fourth phases are the collection of data on the chosen site followed by the analysis of these data. The fifth and final phase is to present the findings to the people and organizations involved in order for them to decide on one or more options.

The Initialization process identifies the possible communities in which the EnPower process can prove to be helpful. The Situational Analysis involves desktop research and field preparation. Preparation for the visit includes: identifying local government departments, political leaders, and community leaders; presenting the toolkit and its purpose to these leaders; and requesting permission from these leaders to engage in working with the community. Next, the site is visited and general data about the site is collected including economic and socio-cultural conditions, community structure, and geographical information, such as distance from the national grid. The information gathered provides the implementing parties with a basic understanding of the situation in the community. The data will later be processed and incorporated with other research information.

The Detailed Investigation and Data Gathering step uncovers the information that is needed to understand the situation in the community and to develop baskets. This is done in three sequential steps, Stakeholder Research, Supply Side Research, and Demand Side Research. The Stakeholder Research identifies possible stakeholders. Once identified, the stakeholders are investigated to determine their interests and involvement in the community. To do this, each stakeholder is analyzed on what his/her interests are and the strength of these interests. Also, each stakeholder is ranked against each other on how well they can work with one another. The information gathered is then entered into a prepared Microsoft Excel spreadsheet.

The Supply Side Research identifies the available fuels and appliances for a community. The suppliers of these resources will be contacted for information on costs, supply options and lead times. It may seem odd to conduct research into what is available before knowing what people want, but this is necessary, in order to insure that the community is not offered options that are unavailable. Offering unavailable fuels might inflate the expectations of the community, decreasing the chances of success for solutions that did not meet these expectations.

Following the research on available suppliers, the Demand Side Research step investigates how energy is used in the community as well as the needs of the community. This step includes a household survey and a Group Meeting Interview. The household survey provides information on the individual households and their energy usage. The Group Meeting Interview provides collective opinions on fuels, services, and the relative importance of various energy issues such as cost and reliability. The goal of the Group Meeting Interview is to gather information on the community's overall preferences in regard to these categories. The completion of the Demand Side Research represents the end of the Detailed Investigation and Data-gathering phase.

The next phase is Calculation and Basket Generation, which takes the information, gathered in the previous phases, and produces energy options that are feasible for the community. The data gathered from both field and desktop research are first entered into a database prepared by the DFID and are then exported to the EnPower software. Next, a set of several baskets are compiled and tested using the program and the data gathered from research. The test consists of various pass/fail checks, which need to meet certain criteria based upon the specifics of a community. The EnPower software can generate reports in various formats, such as comparisons between baskets, information on individual baskets, and a complete general report of the gathered community data and all the generated baskets.

The final phase of implementing EnPower is the presentation of results to all the stakeholders, or storyboarding. This phase overviews what has been completed so far and presents the baskets that have been developed to the stakeholders. The objective of this phase is to open a dialog among stakeholders about the baskets. The desired out come of this dialog is for them to select a basket or set of baskets that will then be offered to the community. The success of this phase would be evident if all of the stakeholders agreed on one set of the proposed baskets. However, a compromise might need to be made in which case the baskets need to be re-drafted before implementation.

Many communities in Namibia are without grid electricity and will not have access to the grid for some time. The introduction of an intermediate level of energisation using various alternative energy sources would provide these communities with an opportunity to enhance their standard of living while they wait for electricity from the national grid. Currently in Namibia, there is no standard process for analyzing the energy usage and the needs of a community (Schultz, personal communication, March 25, 2003). This type of analysis is a prerequisite to any successful energisation project. EnPower, if successfully tailored to Namibia, could become the standard process for analyzing the energy needs of a community. However, EnPower is a new program and has been used only once in Namibia; it needs to be further tested and refined in order to ensure success.

3 Methodology

The EnPower Toolkit is most effective when it is specifically tailored to its targeted community. To ensure EnPower obtained maximum effect, our group set out to evaluate how suitable the toolkit was for Namibia. In addition, we questioned the basic concept behind EnPower to determine if it was valid. Before assessing how well the process was achieved, we first identified four steps that needed to be completed. The first step included identifying conditions upon which to evaluate the process, setting up criteria for those conditions, and finally naming indicators for those criteria. The second step was to complete an analysis and overview of the toolkit, and to develop additions and corrections that would make the process more effective. Thirdly, we implemented the process and upon its completion, we utilized the conditions outlined in the first step to help evaluate the process. The following paragraphs will describe these four steps in more detail.

The initial step involved identifying three conditions on which to judge EnPower, criteria for those conditions and indicators for each criterion that were to be used in Step 4 of our evaluation process. Our goal was to evaluate EnPower, not just for the stakeholder, but also for the user, and therefore the conditions we identified encompassed both of these elements. These conditions were organized into an outline termed the Evaluation Framework for EnPower (EFFE) and are detailed in Appendix A.2. The structure of the outline was broken down into the three sequentially numbered conditions. The first of the three conditions was "EnPower's 7 Objectives are met." We focused on EnPower's seven objectives with the assumption that if EnPower was to achieve its goal, it had to achieve all seven of its objectives. These objectives, previously mentioned in Chapter 2, Section 4, looked at the individual aspects of the process in regards to the stakeholders' interests.

The second and third conditions address how well the process achieved EnPower's objectives at both the micro and macro levels, as experienced by the researcher. These conditions were "the micro-level of the EnPower implementation was completed satisfactorily" and "the macro-level of the EnPower implementation was completed satisfactorily." The "micro" condition looked at how well each of the five individual stages within EnPower was completed, while the "macro" condition was designed to look at the process as a whole. To further illustrate the distinction between the micro and macro conditions, a criterion for the micro condition was "data collection at applicable steps was easy and efficient," whereas an example of a macro criterion was, "the overall flow and completion of the process is easy and efficient."

As previously mentioned, a list of criteria, for each of the three conditions was developed to verify that each was satisfied. The criteria listed under Condition One addressed all the aspects of EnPower's seven objectives by determining if the generated baskets addressed the community's needs, if stakeholder's interests were maintained throughout the process and if data analysis and report generation were successful. Condition Two's criteria focused on the ease and efficiency of the data collection and data analysis phase, whereas Condition Three looked at the overall flow as well as the level of acceptance by the stakeholders towards the EnPower process.

Indicators were developed to aid in determining whether each criterion had been achieved. These lists of criteria were in the form of statements, whereas the indicators were in the form of both subjective and objective questions that could be answered with either yes/no or pass/fail responses. Objective indicators were ideal because they were measurable, yet subjective indicators were still needed. Some evaluations could only be measured against unclear boundaries and not on measurable guidelines. In order to evaluate a situation like this, the researcher was required to draw upon his or her experiences, knowledge and education. An example for the need of subjectivity in our evaluation dealt with the questions regarding software design. There are guidelines in which the evaluator can read and study to gain knowledge on how to evaluate proper software user interface design, however there are no written guidelines on the exact details of designing. For example, there are guidelines for suggested appropriateness on the spacing of text boxes, yet there are no concrete numbers to follow, such as the certain number of inches those text boxes need to be apart from each other.

To condense EFFE, we created three subsequent modules. These modules were sets of criteria and indicators that could be applied or reapplied to evaluate EnPower or any other research process. The creation of these modules also aided in the clarity of EFFE by allowing the reader to get the general picture, while not getting lost in its fine print. The *Information Gathering Criteria Module A* was one such module. It was geared towards satisfying Objective One; more specifically the stakeholders' needs, and consisted of two related criteria and their respective indicators on gathering information. In addition to the stakeholders' needs, we also needed to evaluate how well EnPower's data collection process suited Objective Two, the needs of the researcher. To gauge this, we created the *Information Gathering Criteria Module B*, which was structured similarly to that of the *Information Gathering Criteria Module A*. These two modules could be applied to various information-gathering procedures involved in the EnPower process. The *Computer Software and Tools Criteria Module* was the third module to be developed and was intended to supplement the evaluation of Objective Two. The module focused on the ease of data entry and data analysis for the researcher when generating baskets. It was important to evaluate all computer software and tools because even though the EnPower software and electronic tools were not designed for commercial uses, it was fundamentally important to evaluate the overall functionality of EnPower based upon the user interface design approaches. The Evaluation Framework for EnPower and its three modules can be found under Appendices A.2, A.3, A.4, and A.5, respectively.

After designing the evaluation criteria, the next step was to examine the EnPower process and make any subsequent additions or changes we saw fit. The purpose of these changes was to expedite the questioning process by increasing the ease and efficiency of collecting information. One change we made involved altering specific questions in the individual household questionnaire, although the most significant change we made involved the Group Meeting Interview, as required by the Demand Side Research. We decided that the Group Meeting Interview would be best conducted as a paired comparison exercise that was first introduced to us by Prof. Dick Ford of Clark University (personal communication, February 21, 2003). Our reasoning behind this decision was based on the guidelines outlined in *Listen to the People* (Ghana Organization of Volunteer Assistance, Egerton University, Clark University & University of Arizona, 2001, pp. 40-42). This field guide stated that if a community had never taken part in any type of participatory discussion, like the one outlined by EnPower, pair-wise ranking was recommended. Due to its simplicity of presenting only two choices at a time, pair-wise ranking was said to be less confusing for both the interviewer and interviewees. These changes, including the reworded questions from the individual household questionnaire and the insertion of a paired comparison procedure guideline for the Group Meeting Interview, may be found in Appendix B and D, respectively.

The third step was simply implementing the EnPower process, including the additions and changes made in Step 2. For the most part, the EnPower Toolkit stipulates the implementation process, and although we will not address it here, the process was outlined in Chapter 2, Section 4. The only deviation from EnPower's guidelines made during our implementation process was that we did not carry out the Supply Side Research and it had been already completed previously, and therefore we were not able to evaluate it using our criteria. However, the criteria were set up so that subsequent users could carry out an evaluation.

Lastly, Step 4 involved evaluating the whole process using the framework constructed in Step 1. Our evaluation of the Supply Side Research only consisted of validating the accuracy of the previously collected data from the Okamapuku, Namibia Study that we then reused. From our evaluations on the remaining parts of the three conditions, we were able to evaluate the concept behind EnPower and the creation of "baskets," as well as develop recommendations and suggestions to improve the EnPower process in order to better meet the energy needs of Namibian communities.

4 Results and Analysis

The EnPower Toolkit shows great potential of providing communities in Namibia that are awaiting electrification, with an intermediate solution to their energy needs. However, after evaluation, we have found that the process itself can be further refined and developed in order to effectively provide those solutions. The purposes of this chapter are to first overview our results from using the EnPower Toolkit and then present our evaluation of the EnPower process.

4.1 EnPower Data and Generated Baskets

Before evaluating the process of obtaining the EnPower outputs, it is important to be aware of the actual results of the process. The success and accuracy of these results is one of the major components of the process that is being evaluated. This section overviews the data and information obtained during the implementation of the EnPower process in Ongulumbashe and Okahandja Park. Also, the actual EnPower "baskets" and the results obtained from the storyboarding meeting with the relevant stakeholders are described.

4.1.1 Situational Analysis

The Situational Analysis focused on familiarizing ourselves with the site of our project, two informal settlements within the Khomas Region of the Okuryangava district, more specifically, the neighborhoods of Okahandja Park and Ongulumbashe. These two neighborhoods were originally estimated to have 350 un-electrified households and are located approximately 12 km north of Windhoek (GRN Census Office, 2002, p. 5). As we will discuss below, it was discovered during the Storyboarding phase that these neighborhoods actually encompass closer to 1,400 households. These two areas are distinguished from other informally settled areas surrounding Windhoek because they share a common church that provides some community structure. In addition, Okahandja Park is currently in the process of being formalized by the municipality. Efforts by the city have been started to create formalized plots so that utilities may one day be provided, such as grid connections and a sewer system (Hugo Rust, personal communication, March 25, 2003).

Upon our initial visit to our site we were able to meet Vicar Cloete of the Gowaseb Evangelical Lutheran Church, which was constructed in 2001 on the hillside overlooking Okahandja Park and Ongulumbashe. Among other things, he was able to confirm our assumptions stating that the church offers the most direct formalized structure in the community (Vicar Cloete, personal communication, March 19, 2003). Originally, we were told that the church, with a parish of approximately 1,000 worshipers, has a considerable amount of influence in the community. It was later determined that the actual population size of Okahandja Park and Ongulumbashe is not appropriately represented by only the Gowaseb Evangelical Lutheran Church.

4.1.2 Detailed Investigation and Data-Gathering

The Detailed Investigation and Data-Gathering stage uncovered the information required to understand the community's needs and develop appropriate baskets. Some of these data, such as demographic data, were used to give the researchers as well as the stakeholders a sense of the situation in the community. These data, such as average household size and composition, while still useful to the researcher in understanding the community, did not serve as a direct input to the basket generation. Due to this they are not discussed here, however the complete reports of all field research data can be found in Appendix G. The data topics that directly influenced the generation of baskets were income, fuel usage and expenditures, and fuel preference and energy issues rankings, termed “dimensions” rankings. The first two data topics were collected from the Individual Household Survey, while the fuel preference and dimensions rankings were collected from the Group Meeting Interview.

Individual Household Survey

We surveyed 36 Individual Households using an EnPower designed questionnaire, and from these we were able to gain information on income as well as fuel usage and expenditures. The average household income within our sample group was found to be approximately N$1100, with almost all of the sampled population earning less than N$3,000 a month. As will be discussed below, we discovered during the Storyboarding phase that the actual average was approximately N$750 a month. We established the division between low and medium income brackets at N$1100, according to the original figure we calculated. With this division we noticed that within our sample size the distribution of low and medium income households was unbalanced, with Okahandja Park having more low-income households and Ongulumbashe having more medium income households.

In order to assess energy usage in the community, it was necessary to examine both the types of appliances used and the amount of time each household spent using the provided services. These services included cooking, water heating, ironing clothes, lighting and listening to the radio or watching TV. There were four “appliances” used for cooking, of which a gas stove, paraffin stove and an open fire were most common. Data regarding the other activities can be found in Appendix C.

From this, the average amount of time spent cooking each day was determined. It was estimated that most families spent between three to six “plate hours” cooking each day. Plate hours are defined as the number of plates or pots that are used for the duration of cooking a meal, factored by the duration of time for preparing the meal. For example, if two pots for cooking are used for two hours to prepare a meal, the meal requires four “plate hours.” From these data we were able to determine the amount of energy consumed and therefore the fuel usage. The data on fuel usage could then be used with information on fuel costs, also collected during the survey, in order to calculate expenditures.

Even though the data collection from the 36 households was “successful,” there are several considerations that need to be looked at. For example, the actual Okahandja Park and Ongulumbashe population consists of 1,400 households; however, our sample size only consisted of 36 households. According to EnPower guidelines, for any community consisting of more than 300 households, the sample size is suggested to be at least 70 households (AEA Technologies et al, 2003, G5, p. 3). Due to this under-sampling the collected data may not accurately represent the entire community. Another important factor is that the translators only spoke Nama-Damara, and many of the respondents our translators chose were Nama-Damara speakers. This also may have led to a misrepresentation of the Okahandja Park and Ongulumbashe communities, as there were other ethnic groups that should have been included in our sample but were not. Using the Gowaseb Evangelical Lutheran Church as a communication point affected these factors because the participants were all from the same ethnic group. Besides the Gowaseb Evangelical Lutheran Church, there is reported to be another church, which was informally established in the Okuryangava community that should have been contacted. In addition, we discovered there is an Oshiwambo church in the area. We did not pursue visiting either of these churches and it is possible that they are one and the same. By not visiting or contacting these churches, our representation of the community may be inaccurate.

Group Meeting Interview

The Group Meeting Interview was conducted at the Gowaseb Evangelical Lutheran Church using a paired comparison method. The purpose of the group interview was to gather opinions regarding fuels, services and the relative importance of energy issues in order to assemble a general preference ranking of these categories. Although this procedure proved to be somewhat difficult, we were able to obtain most of the information needed. For the information that we were unable to collect, due to time constraints, we extrapolated the results based upon the data we were able to collect. For example, information on the fuel preference for space heating was not obtained, but from previous preferences for other energy services, the grid electricity would have been the first choice of fuel for that service, whereas charcoal would have ranked last. The details of the rankings can be found in Appendix G.4.

The fuels we considered included paraffin, LP gas, wood (open fire), wood (wood fuel-efficient stove), charcoal, solar, and legal grid electricity. Some of these fuels ranked higher or lower, depending on what service we were focusing on. For example, LP gas ranked 2nd for cooking, yet 5th for refrigeration/freezing. Reasons for this preference ranking might include cost and convenience. For services like cooking, lighting, and space heating the fuels often were ranked in the following order: from electricity (preferred), LP gas, paraffin, wood, and charcoal last. When applicable, solar ranked 2nd or 3rd, after electricity, for services like water heating and refrigeration/freezing. As a rule though, grid electricity always came out first and, and when appropriate, charcoal last.

The Group Meeting Interview tended to follow certain patterns, however there were some anomalies that raised validity issues. The second half of the Group Meeting Interview concerned a preference ranking of dimensions like affordability, appearance, convenience, safety and reliability. In general, "affordability" ranked as the highest priority, with "convenience" and "safety" in second and third places, respectively. When asking about lighting, it was interesting to note the result of the comparison between "safety" and "appearance." Although the final ranking was not affected, the "appearance" of light-supplying appliances was considered more important than their "safety."

It was anomalies such as "appearance" being ranked over "safety," combined with some difficulties that we experienced in conducting the meeting, which raised validity issues for the data gathered from the Group Meeting Interview. There were many factors that contributed to our difficulties in completing the rankings required by the Group Meeting Interview. The group meeting was conducted after sunset in a building without electricity, which resulted in inadequate lighting and made it difficult for us to see the meeting attendees and for the attendees to see the visuals we used to aid in clarification during the discussion.

In addition to the lighting issue, the large group attendance of more than 150 people proved difficult to manage. The attendance size was at least five times EnPower's recommended participant number of 20 to 30 people. The main reason for the large turnout was the fault of holding the meeting in lieu of a regularly scheduled Lenten service. The combination of a large group size and poor lighting made it difficult for both attendees and researchers. It was difficult for the attendees to express their confusion and ask for clarification on the instructions and questions. The accumulated difficulties resulted in a lengthy meeting that took two hours to complete. By the end of the exercise, the attendees were tired and restless and seemed to have lost interest in the goal of the meeting.

The language differences and translation difficulties were additional obstacles we had to overcome. Not having briefed our translator, Vicar Cloete, in advance on the content of the process, added to our difficulties. Some of the difficulties were found in trying to explain the instruction that the attendees were to consider only two items at a time in order to make a decision on one. It was also difficult to explain the concept of a "dimension" and the various kinds through a translator. The paired comparison exercise began with these concept comparisons, which further confused the participants, who were trying to understand the instructions as well as the concepts being presented to them. Concerning validity issues involving language barriers, we were unaware that Pastor Petrus was possibly influencing the community members to vote for appliances they did not have, regardless of their true fuel or appliance preferences. Because the Pastor was speaking to the participants in Nama-Damara, we did not learn of this possible influence until after completing the meeting.

4.1.3 Generated Baskets

Once all the information regarding energy supply, usage and preference was gathered, the information was entered into the Data Collation Tool, and baskets were generated using the EnPower Algorithm software. The output of this process was two sets of baskets, six for the low-income households and four for the medium-income households. These ten baskets had some similarities and differences that will be described below. The details of the baskets can be found in Appendix G.6 and G.8.

Of the six baskets generated for the low-income bracket, the first three included lighting, radio and cooking services, while the second set of three contained refrigeration in addition to these services. Also, half of the low-income baskets offered limited electricity grid connection, whereas only one of the four middle-income baskets offered limited grid-based electricity. Although this may seem contradictory, the other three middle-income baskets incorporated complementary forms of modern energy equipment like solar-energy home systems.

When generating baskets, specific considerations for designing various levels of baskets were kept in mind. Within each income level group of baskets, each subsequent basket offered an increased number or quality of services. For example, in the low-income bracket, Basket 2 offers a *single*-plated low-pressure gas stove, whereas Basket 3 offers a *double*-plated low-pressure gas stove. In addition, it was found that the life cycle costs of a basket and its initial capital costs were inversely related. The life cycle costs associated with each basket consisted of the capital costs of purchasing appliances and equipment, the initial fuel access costs, and the monthly fuel consumption and maintenance fees calculated over a ten-year period with interest rates and inflation rates considered. In most cases, the initial cost of a higher-level basket can be "paid-off" over time with less monthly fuel and maintenance costs, whereas the lower-level baskets had less expensive initial costs, but higher monthly operational costs. An example of this can be seen within the medium-income Basket 2 and Basket 3. Basket 2 offered a variety of services for an initial cost of N$18, 251.74, with a monthly cost of N$326.03. Basket 3 however offered more services than Basket 2 but for an initial cost of N$35, 329.61 and only a monthly cost of N$275.90.

4.1.4 Storyboarding to Stakeholders

The Storyboarding phase involved presenting our results from the EnPower process to our stakeholders. The meeting was structured as an open forum and generated discussion on energy options and energy upliftment in areas surrounding Windhoek, concentrating on Okuryangava. The main focus of the meeting was to obtain feedback from the stakeholders on the findings developed by EnPower. Also, the meeting aided in the validation of the data, which was collected during the Data Gathering phase and mentioned previously in this chapter.

After the completion of storyboarding to the stakeholders, the general consensus was positive. This meeting served to facilitate discussion about EnPower and proving energy the area of Okuryangava. The stakeholders seemed to have accepted the concept of EnPower and its goals, and realized the potential EnPower holds. It was mentioned that Premier Electric and NamPower be contacted on becoming involved with the EnPower program. Further examination of their feedback is discussed later in this chapter.

From the meeting, we were able to identify discrepancies between our collected data and information held by the municipality. One of the first discrepancies uncovered during the discussion with our stakeholders, regarded our demographic data. We learned from Hugo Rust of the City of Windhoek, Division of Sustainable Development, that the estimated number of households in Okahandja Park and Ongulumbashe is presently 900 and 500, respectively. This discrepancy with our original estimate of 350 households total was confirmed by crosschecking the data with those found in *The Feasibility Study for the Upgrading of Okahandja Park A, B & C: Final Report*. When this feasibility study was conducted in 2000, Okahandja Park alone was recorded as having between 1,000 and 1,200 households and based upon this the current estimate of 900 households seems more accurate than our original estimate of 350 (2000, p. 5).

In addition to these demographic discrepancies, we also found a discrepancy concerning the average household income in the community. According to both Rust and *The Feasibility Study* we overestimated the average income in the community. In contrast to our sample average of N$1100 per month, we learned that the average income is really between N$501 and N$800 a month (2000, p. 5). We also obtained advice on how to better substantiate income figures for future implementations, by attaining salary slips from employed household members and accounting for subsidies within a household. These two tips are meant to further aid in the crosschecking of income figures.

Of these discrepancies, the one regarding monthly income had the potential to affect the generated baskets the most. The reason for this was because the baskets may have been designed for an income level higher than the residents' true income levels. Due to this overestimate, the community members might not be able to afford the generated baskets. As stated by EnPower, one of the prerequisites of a basket being successful is the ability of the community to afford it. Since these baskets may not be affordable, they might not be appropriate.

4.2 Evaluation and Recommendations

Once our implementation of EnPower was completed, evaluations of the toolkit, research and analysis process, and the results were undertaken. The Evaluation Framework for EnPower (EFFE) provided a guide for this assessment and has been discussed in detail in Chapter 3. The EFFE outlines the three conditions to be considered, Stakeholder Relevant Condition, Micro-Level Researcher Relevant Condition, and Macro-Level Researcher Relevant Condition. In accordance with EFFE our evaluations and recommendations are organized into these three categories.

4.2.1 Stakeholder Relevant Condition: EnPower's Seven Objectives

According to Condition One in EFFE, EnPower had to achieve its seven objectives in order to achieve its goal. To determine if EnPower's seven objectives were achieved we used six prescribed criteria and their particular indicators outlined in the Evaluation Framework for EnPower (EFFE), which can be found in Appendix A.2. While four of the six criteria were achieved, the remaining two have either yet-to-be achieved or were unsuccessful. The following section will discuss the four passing criteria, the yet-to-be achieved criterion and the failing criterion. In closing, the need for each of the seven objectives towards achieving EnPower's goal will be examined.

After completing the EnPower process, we examined all six criteria and found that four passed. These criteria focused on the completeness of the information collected, if the generated baskets accommodated the community's needs, if stakeholder support was maintained throughout the EnPower process and if influences by energy suppliers were prohibited, respectively. We found that the information collected during the Data Collection phase was complete, relevant, useful and used based upon the indicators laid out by EFFE. We believed that the questions and question topics were understood, there were no questions left unanswered, and all the collected data was used in the data analysis step. We also determined that, based upon the positive reaction towards the EnPower process by those in attendance during the Storyboarding phase, the criteria regarding stakeholders' interests being maintained was achieved. In addition, we found no sign of energy supplier's influences on energy decisions for the community.

Of these four passing criteria, the criteria dealing with whether or not the generated baskets accommodated the community's needs was the least obvious and required the most consideration. Initially, it seemed to fail because, as determined during the Storyboarding phase, the baskets generated were based upon an incorrect level of income. Therefore, it was assumed that the proposed baskets might not have accommodated the community's resources. However, upon further consideration it was discovered that the Storyboarding phase provides the researcher with an opportunity to verify community data with all the stakeholders. Based on the information gained from this discussion, the researcher then has the ability to redevelop and recalculate the baskets and in doing so, it is possible that the newly generated baskets will better accommodate the community's needs and resources. At this point, the EnPower process emphasizes the need to continually refine the baskets until they fit the community's needs as well as possible. By properly completing this Storyboarding phase, the possibility of generating baskets that do not fully accommodate the community's needs and resources is eliminated, thus, it is unlikely that this criterion will fail. As a suggestion, to help reduce the amount of time consumed by this refinement process, it would have been advantageous to confirm the data gained during the Data Gathering phase prior to generating the baskets.

Criterion Five, which determines if all stakeholders agreed upon implementing one of the proposed baskets for each income level, has yet to be utilized due to time constraints on the project. As already stated, the baskets proposed during the Storyboarding phase displayed discrepancies in average income, which suggests the baskets might not accommodate the resources of the community. Therefore, the baskets need to be further refined and re-presented to the stakeholders until these discrepancies are eliminated. We will not be conducting this process, as R-3-E will take over the responsibilities of redeveloping and re-presenting EnPower's results to the stakeholders.

Lastly, examining the sixth criterion regarding data analysis and report generation, the report generation step was only partially successful, and therefore we considered the whole criterion failed. Data analysis and basket generation were successful, providing valid baskets, however some of the figures calculated in the reports generated by EnPower in the last step of the process, were illogical and had no explanation where they were derived from. Due to these ambiguous reports, we did not feel prepared enough to present EnPower's findings during the Storyboarding phase. Instead, we were required to calculate the figures by hand. The failure to meet this criterion proved to be a major finding because the Storyboarding phase is thought to be the most important phase in EnPower. This step is considered the most important because it is the transition between gathering research data and providing energy solutions to the community. Based upon this failure, it is necessary to further develop the EnPower software to eliminate these uncertainties.

In addition to determining if the six criteria for EnPower's seven objectives passed, we also examined the value of each objective. We found that the seven objectives could be more concisely rewritten into three objectives and still meet EnPower's goal. This was based upon the assumption that some of the objectives overlapped, while others were unneeded. These recommended objectives are:

1. Obtain a thorough assessment of community members' resources and energy needs and preferences.
2. Develop baskets that serve as complete energy solutions that take into account community members' resources, needs and preferences.
3. Involve all stakeholders in decisions on energy solutions to provide everyone with a voice.

The first objective focuses on the researcher successfully obtaining all information regarding the community's resources and energy needs and preferences. Objective two sequentially follows this objective, as it addresses the need to assess both individual and community energy demands with multiple fuel solutions. Following this, objective three ensures that all relevant stakeholders are kept informed and that their interests are maintained.

4.2.2 Researcher Relevant Condition: Micro-level view

One of the important aspects of evaluating the EnPower process requires that the process be reviewed at the micro-level of implementation. Looking back at the EnPower process and its results, the entire process was completed and the necessary data were collected without significant difficulties. Though all five stages of the EnPower process are important, the *Detailed Investigation and Data Gathering* and *Calculation and Basket Development* stages have more weight in affecting the results of the process and will be more thoroughly reviewed. The Detailed Investigation and Data Gathering stage consisted of the Stakeholder Research, Supply Side Research, and Demand Side Research. Our group did not conduct the Supply Side Research, and therefore the process itself has not been evaluated. The validated and updated information from this step can be found in Appendix G.3. The Calculation and Basket Development stage consisted of data entry into the database provided by EnPower and generating baskets with the

EnPower Algorithm software. We have evaluated the stages in the order laid out by the EnPower process.

Demand Side Research

The first of two parts of the Demand Side Research, the Individual Household Survey, was conducted successfully without any significant difficulties. However, there were issues regarding the data's accuracy. Though difficulties were found in conducting the Group Meeting Interview, the second part of the Demand Side Research, it was still possible to obtain the necessary data. We will first examine the Individual Household Survey, followed by the Group Meeting Interview.

Looking at the criteria outlined in the Evaluation Framework for EnPower that can be applied to the Individual Household Survey, the data collection for 36 households was completed within a reasonable amount of time. We found the EnPower guidelines were correct in that as we gained more interviewing experience, the length of time for completing an interview decreased considerably. There did not seem to be any major obstacles for the respondents in answering the questions as evident from the fact that we were able to collect all of the relevant information asked for in the questionnaire. The changes that we made to three of the survey questions aided in the efficiency, completeness of conducting the interviews as well as providing for validity checks. For more details on these changes, please see Appendix B.

Besides the modifications that we made to the Individual Household Survey, there were other factors that aided in the overall success of the data collection process. For example, it was helpful to first interview the three translators who accompanied us because it provided the translators with a better understanding of the questions that they were to then translate. Their understanding of the questionnaire's content helped in the efficiency of the interviews. In addition to the translator's help, the Vicar was extremely helpful in opening up communication with the ISA residents. Since the Vicar held an authority position within the community, the residents seemed more willing to participate in the interviews. It should be noted that the community's general willingness to participate was also helpful. Their openness provided a friendly atmosphere allowing us to comfortably and efficiently conduct our research.

Even though collecting the necessary data during the Individual Household Survey step was not difficult, we discovered during the Storyboarding phase that some of the data were inaccurate. For example, as previously mentioned, the average household income based on the interview data was estimated to be significantly higher than the municipality's estimate. According to Bernard (2002, p. 49), data gathering in the field should be validated using triangulation methods. The EnPower toolkit should provide such guidelines to help a researcher, especially inexperienced researchers, in validating data during field research, not only after data analysis has been completed. These guidelines do not have to be followed if it is not necessary for the researcher to further verify the validity of an answer. However, it would be helpful if the researcher was provided with "fall-back" procedures if a situation arises. An example of a helpful validity check involves obtaining accurate income figures. The researcher should ask for proof of income such as paycheck receipts. The researcher can then later validate the figure that the respondent gave with the paycheck receipt figures and the income expenditures they report later in the questionnaire.

During the second half of the Demand Side Research, the Group Meeting Interview, many difficulties were experienced. Despite these difficulties we were able to obtain or deduce results for all of our preference categories. Upon reviewing the process that was used to conduct the Group Meeting Interview we were able to suggest improvements that could help to make the process more efficient as well as eliminate some of the validity issues that we encountered.

Our suggestions are meant to solve the various problems that we encountered. One of the largest problems that we encountered was with translation. If a translator is needed he or she should be briefed ahead of time on the process that will be conducted during the Group Meeting Interview. This will allow the translator time to think through the translation as well as ensure that he or she understands the process. A second problem we had was the poor lighting in the Gowaseb Evangelical Lutheran Church. This made it hard for participants to follow what was happening and hard for the facilitators to judge the responses of participants. In order to reduce these problems, future meetings should be held during the day or in an area with adequate lighting. The size of the group also presented difficulties by hindering participants from asking for clarification on the instructions that had been given. In this case, keeping the number of participants to EnPower's suggested 20 to 30 people should reduce confusion. Our suggestion to remedy this situation would be to use a selection process where 50 community members are asked to attend the Group Meeting Interview. These people will be told of a specific time and the content of the meeting. We predict that 20 to 30 of these invited community members would attend. However, the researcher should be prepared for all 50 invited residents to attend. Appropriate resources for the meeting, such as a few sets of pictures and charts and appropriate translators, should be prepared in the event that the larger group needs to be divided into sub-groups. This will help to avoid large participant numbers. Specifying a time of day that is more appropriate for conducting the interview should also make the process operate more efficiently. The researcher should be prepared for an unexpectedly long meeting, and provide refreshments in the event that the respondents need a break. Allowing the respondents some rest period would refresh them and keep them focused on the task of the meeting.

Calculations and Basket Development

The Calculations and Basket Development phase was conducted with almost no errors. There was only one error found at the end of the process. However, this error proved to be a major flaw of the EnPower process. Before discussing this flaw, we will elaborate more on the positive aspects of the two main steps that need to be analyzed: data entry using the tools provided by EnPower and basket generation using the EnPower Algorithm software.

The main data entry tool is the Data Collation Tool (DCT) that incorporates all of the information from the Individual Household Questionnaires into one database. The data entry was completed without major difficulties. The main difficulty we encountered had to do with using an old version, 0.03.00, of the EnPower manual with the latest version, 1.00.00, of the Data Collation Tool software. When we were able to obtain the EnPower manual that was for the version we were using, many clarifications were made. Though the data entry was completed, there were observations on slight modifications or suggestions that could be made to aid the user in additional data entry efficiency. An example of a recommended revision to the DCT involves providing "super-user database capabilities" to the data entry person. This would have proved helpful during data entry when we discovered that appliances such as a paraffin space heater and a gas stove used for baking were not available for selection in the appliance availability data page. As a result, when we entered an estimate of the fuel consumption for these appliances, errors in subsequent calculations might have resulted. The complete list of observations regarding both the DCT and EnPower's subsequent algorithms can be found in Appendix F.

Data entry into the Data Collation Tool also provided a straightforward method of exporting the entered data to the EnPower software. There were no errors encountered in the exporting process and, after reviewing the exported data within the EnPower Algorithm, the information was found to be correct. Reviewing the data involved looking at the reports that the EnPower software produced for verification purposes at the beginning of the EnPower software sequence. Any anomalies were adjusted as needed. Further details can be found in Appendix F.

The partner relationship feature between the Data Collation Tool and the EnPower Algorithm was extremely helpful in conserving time. There were other data entry components of the EnPower process, including the Situational Analysis Microsoft Word document data table, the Stakeholder Research Microsoft Excel spreadsheet, and the Supply Side Research Microsoft Excel spreadsheet, that was not directly used in data analysis and basket generation, and only served as organizational tools for electronic copies of the data. Instead, the information held in these tools must be manually entered, when required, by the EnPower software user, resulting in repeated data entry. Because the data from Situational Analysis, Stakeholder Research, Supply Side Research, and Group Meeting Interview needs to be electronically entered, it would be logical if a feature similar to that found between the Data Collation Tool and the EnPower Algorithm software could be developed between those other spreadsheets and the EnPower Algorithm.

After data entry, generating and testing baskets to meet researcher-defined service requirements was found to have almost no errors. The testing of the baskets showed that the baskets we defined provided the desired services for the community members. The main error we found during this process was found in the cost figures of the baskets that were calculated by EnPower. These figures seemed inaccurate, and we were unable to discern how they were derived. Therefore, we were not prepared to present these figures to our stakeholders at the Storyboarding phase. Because the figures calculated by EnPower could not be used, we were required to manually calculate the associated costs with each basket. The process of developing these figures consumed an unnecessary and large amount of time that could have affected our ability to present findings to the stakeholders in the allotted time frame. To avoid such an obstacle, EnPower should provide detailed descriptions of calculations so that the researcher can better understand those figures in order to present them. These descriptions should be included in the EnPower Manual, where the researcher can easily locate the information.

Storyboarding and Presentation to Stakeholders

After meeting with the relevant stakeholders, the general feedback on our findings and EnPower results were positive. The findings we presented specifically focused on information gained during our data-gathering phase and the baskets generated based upon these data. The intent of this open forum was to present our findings to our stakeholders and obtain their feedback on both the data collected and the different baskets generated. The report of our findings on the generated energy options and information regarding the meeting can be found in Appendix G.7, while the feedback we received and our findings are highlighted below.

Besides being made aware of the apparent inconsistencies in demographic and income data, we also received remarks regarding the overall EnPower process. We learned from those in attendance that they generally thought the EnPower process was a good one with good intentions. Those in attendance also made suggestions on how to further develop the EnPower process and increase its effectiveness. We decided that these suggestions were helpful and we recommend they be implemented in the future.

One suggestion we received regarding the EnPower process was that it would be more effective if it was combined with an existing feasibility study or done in conjunction with a low-cost housing project. Furthermore, it was mentioned that a pilot project for implementing basket options needs to be done to see how well the baskets work. It was also mentioned that the generated baskets needed to be upgradeable to leave room for modernization over time.

In sum, the EnPower process was regarded as potentially very useful, but it still needs improvement. It was recognized that EnPower is only one piece of the social upliftment puzzle and would most likely work best in conjunction with socio-economic development projects.

4.2.3 Research Relevant Condition: Macro-level view

The EnPower manual sets out guidelines for the smooth and efficient completion of the process. During our implementation we came across only one significant setback, but this was due only to our deviation from EnPower's guidelines. From our implementation we were also able to develop suggestions for future users of EnPower to increase the efficiency of the process. Unfortunately, this analysis of the macro level of the EnPower process is incomplete. We have only made judgments on the overall flow of the EnPower process, and were unable to judge the acceptance of EnPower by all of the stakeholders, as the process of basket selection has not been completed.

The EnPower process is straightforward and moves from one phase to the next in a logical fashion. The manual lays out the process in a clear and detailed manner that is easy to follow. If researchers follow these guidelines, they should have success in their implementation of the EnPower process. The EnPower manual does allow for flexibility in implementation, but the researcher should be careful not to deviate from the intent of instructions in the manual.

When looking at the overall flow of our implementation we found that the transition from Stakeholder Research to Demand Side Research was hurried. Due to time constraints, we attempted to begin the Data Collection Phase before all of the relevant stakeholders within the municipality could be made aware of our project. As a result, failing to gain the support of important officials within the city could have jeopardized our research. Fortunately, after some initial tension, the stakeholders within the municipality were supportive of EnPower and its goal. This potential problem with obtaining the support of all relevant stakeholders could have been avoided entirely if we had followed the guidelines set out by EnPower. The EnPower manual makes it clear that each phase of the process should be completed before the next phase begins.

With this in mind, the researcher needs to allow enough time for the completion of each phase so that overlapping phases do not occur.

The EnPower manual sets out the guidelines for a successful implementation. However, from our experience we are able to provide the future user with more suggestions on efficiency than those covered by the EnPower manual. One important aspect that is insufficiently covered in the EnPower manual is the training of new users. Users need to have knowledge of surveying methods and procedures, cultural norms and practices of the area, as well as extensive knowledge of the EnPower Toolkit. If the user has knowledge or experience with conducting surveys as well as an understanding of the culture, he or she will be more capable in conducting the survey and acquiring complete and accurate data. The surveys will be more efficient and produce better data, as the interviewers will be better able to phrase questions and spot inaccurate answers. Extensive knowledge of the EnPower Toolkit will aid the user in all aspects of the process by giving an understanding of how each part contributes to the whole, allowing for more fluid phase transitions.

Another way in which efficiency can be improved is by adding validity checks to each stage of the process. EnPower uses the Storyboarding process as a validity check by asking for feedback on data from stakeholders. The Storyboarding process is an effective way to validate data, but occurs after the completion of the rest of the process. This means that a significant amount of work has already been put into processing data that may be inaccurate. In this case, during the Storyboarding meeting, if the data are found to be incorrect then the baskets may need to be redeveloped. This effort could have been avoided or at least reduced by adding validity checks throughout the process to ensure that information obtained is accurate before the process is allowed to continue. Based on our experience, these recommendations should help the future user to conduct the EnPower process more efficiently

The second half of our macro evaluation of EnPower was the acceptance of the EnPower process. Unfortunately, we were unable to evaluate this criterion since the generated baskets are in the process of being refined after initial feedback from the stakeholders. The stakeholders have accepted the EnPower process and result in principle, but it is still unclear if this acceptance will lead to a successful implementation of selected baskets.

5 Conclusions and Recommendations

The EnPower Toolkit is a potential first step in developing a comprehensive energy upliftment procedure. The concept of offering options for complete energy solutions to a community helps to address several problems that have been faced by energy upliftment projects in the past. The tools and procedures in the toolkit, however, need further development before they can be used extensively. This development should include additional tests of data collection procedures and the software algorithms. These tests should be conducted in order to thoroughly analyze the toolkit with the intent of improving its utility.

Providing a community with energy solutions that address all of the household energy needs is ambitious but may be the most appropriate answer. This approach brings together all the various fuels and appliances households would need to meet their minimum required energy services or improve upon them, thus simplifying the selection process. The "basket" concept also gives outside stakeholders, such as a municipality or energy service provider, a single set of packages to offer to a community that addresses all energy needs allowing them to simplify delivery. The EnPower process also provides the community with the opportunity for involvement by allowing community members to select from baskets that have been tailored to their needs. By allowing the community a voice in the final selection, the chances that they will accept the final product are increased.

Although the EnPower concept seems to be an appropriate answer to the problem of providing modern energy services to poor peri-urban and rural communities, the tools and procedures included in the toolkit require more development. The major issue that needs to be addressed is the EnPower Algorithm and why it produced illogical numbers with no explanation as to their origin. This meant that many of the data that were supposed to be presented to the stakeholders were unavailable at the time of storyboarding, as discussed in Chapter 4, Section 2. Other issues are of lesser significance but affect the efficiency of the process and should still be addressed in further refinement of the EnPower Toolkit.

The overall success of the EnPower process for Okuryangava is still unknown at the time of writing this report. An implementation of baskets has not been conducted and is not included in our evaluation. The stakeholders seemed to be genuinely interested in the obtained results and enthusiastic about EnPower's potential. This is encouraging for the success of future projects in Okuryangava that may result from our work, but there are no guarantees that enthusiasm will last. The EnPower concept, though it may seem logical, is still unproven, and no demonstrated evidence of its ability to succeed is available. This lack of evidence to prove that EnPower is capable of succeeding is the primary reason for the need for further research and testing.

The Evaluation Framework for EnPower (EFFE) could be utilized in future evaluations of EnPower. The Evaluation Framework for EnPower helped structure our evaluation of the

EnPower Toolkit, allowing us to give a more comprehensive analysis. Despite this, our evaluations and analysis may be met with skepticism from some readers, since EFFE does not represent a proven methodology for system analysis, and it is lacking in other areas of detail. The task of improving EFFE would be simple for a researcher equipped with the proper resources. With the knowledge of accepted procedures for analyzing processes that could be applied to EnPower, EFFE could be modified so that it can produce results that are more credible. With the appropriate information on human computer interface design, the evaluation of the EnPower software tools could be greatly expanded, allowing for more detailed and useful suggestions for improvements. The Evaluation Framework for EnPower could also be improved by adding steps to verify calculations. This would require information on how the EnPower Algorithm calculates data as well as scientific information on the energy contained in various fuels and how that energy is consumed by appliances.

After these improvements have been made to the Evaluation Framework for EnPower it can be utilized in conducting further tests of the EnPower process. These tests should be focused on developing the software and fine-tuning the process as well as proving the validity of the EnPower concept. The first objective of developing software and fine-tuning the process can be achieved with EFFE. Proving the validity of the EnPower process would require an analysis of the basket implementation as well as follow-up research in the selected area. This follow up research would need to be conducted six months to a year after implementation (Niels Wormsbächer, personal communication, April 25, 2003) and would analyze whether the implemented baskets remained in use or had failed over time. If the EnPower Toolkit can be further refined and its validity proven, it will be able to serve as a standard, for providing intermediate energy solutions to communities in need.

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Appendix A:
Evaluation Framework for EnPower (EFFE)

Appendix A.1

Methodology outline

Methodology for a evaluating the EnPower process:

1. Set up evaluation criteria, with indicators.
2. Analyze and review toolkit before implementation. After overview, include our own additions or changes that would make the process more effective. (i.e. using paired comparisons for the "Group Meeting Interview")
3. Implement the process.
4. Evaluate process using the criteria and indicators already listed.

APPENDIX A.2

Evaluation Framework for EnPower (EFFE)

1) Condition
   a) Criteria (The criteria listed under Condition One are intended for one or more of EnPower's Objectives and these EnPower Objectives are denoted within parentheses)
      i) Indicator
         (1) Notes
            (a) Further Notes

EnPower's 7 Objectives (as stated by the EnPower Toolkit):
1. Community and individual needs and aspirations are taken into account
2. Supply industry dictated solutions are tempered
3. Multiple fuel or integrated energy solutions are encouraged
4. All household energy needs are addressed simultaneously – eliminating isolated decisions
5. Management of significant stakeholder interests
6. Analysis of decision drives from an economic, preference, intent and benefit perspective
7.Ensure a "best compromise" selection decision is taken

1) EnPower's 7 Objectives are met
   a) The information collected is complete, relevant, useful and used (Objectives: 1, 3, 4, 6, 7)
      i) Apply *Information Gathering Criteria Module A* on Situational Analysis, Stakeholder Research, Supply Side Research, "EnPower Present Benefits Research Questionnaire - Individual Household", "EnPower Research Questionnaire - Community Session (Group Meeting Interview)"
   b) The generated baskets accommodate community/individual needs and resources (Objectives: 1, 3, 4, 6, 7)
      i) Can people afford the various baskets that are proposed to them? -- Objective
         (1) Do people's income availability logically coincide with the mathematical calculations of EnPower?
            (a) For example, are there baskets that total a certain amount but people cannot afford it, even though their income level was provided during analysis?
      ii) Were appliances and fuels in the generated baskets according to the preferences and needs of the people in the community? -- Subjective
         (1) Are there combinations of fuels and appliances that contrast with the information collected from the people?
      iii) Did the generated baskets offer only the fuels and appliances that are available to the community? -- Objective
         (1) Check with supply side research.
   c) Stakeholders' support is maintained, their interests are considered during data analysis/basket generation and they are well informed of result/basket options (Objectives: 5, 6, 7)
      i) Were stakeholders' interests taken into account during data analysis? -- Objective
      ii) Have stakeholders been updated or informed of findings on community needs? -- Objective
      iii) After initial presentation of EnPower to the stakeholders, do they have a genuine interest in EnPower's goal? -- Subjective

iv) Have the stakeholders been contacted soon after basket generation to discuss community energy options? – Objective
v) Did the stakeholders and community members easily understand the “baskets” presented to them? -- Subjective
(1) In regards to the message being relayed, the format of reports
(2) Did stakeholders ask many questions about what was presented? How many? What were the questions on?

d) Influence by energy suppliers, researchers and/or EnPower on the community is not allowed (Objective: 2)
i) Are there specific preferences towards using an energy source? – Objective
(1) This information is gathered from the “EnPower Research Questionnaire - Community Session (Group Meeting Interview)”
(2) If so, which energy sources? Was there any supplier influence involved?
ii) Was all energy services used or mentioned by the individual household included in the data collection (the survey)? -- Objective
(1) If not, which ones?
iii) Are all energy services and needs of that household included on the survey during the particular interview sitting as to not indirectly impose biases? -- Objective
(1) If not, which ones?

e) All stakeholders, including community members, agree upon implementing one of the proposed baskets per income level (Objectives: 6, 7)
i) Did the stakeholders and community members come to an agreement? – Objective

f) Data analysis and report generation are successful (Objectives: 6, 7)
i) Was data analysis completed? -- Objective
ii) Were calculations from EnPower software correct? -- Objective
(1) Were mathematical calculations correct? Check mathematical calculations against what the computer software produced. It should be noted that small errors might not be caught such as rounding errors.
(a) How many? Which ones specifically?
iii) Did reports have correct information transferred from the use of the EnPower software? -- Objective
(1) If there were errors, how many? What were they?
iv) Did the reports have easy to read formats? -- Subjective
(1) General aesthetics - what we think looks good, no obvious offensive formats, layouts; as well as cognitive psychology of computer software design

2) The micro-level of the EnPower implementation was completed satisfactorily (at individual stages)
a) Data collection at applicable steps was easy and efficient.
i) Apply *Information Gathering Criteria Module B* to the data collection steps (Situational Analysis, Individual Household Survey, Group Meeting Interview, Stakeholder Research, Supply Side Research)
b) Data analysis at applicable steps was easy and efficient.
i) Apply *Computer Software and Tools Criteria Module* on all applicable electronic databases, spreadsheets, software, and data tables. (Found for Situational Analysis, Stakeholder Research, Supply Side Research, Demand Side Research, Calculation & Basket Generation)

3) The macro-level of the EnPower implementation was completed satisfactorily (the overall process)
a) The overall flow and completion of the process is easy and efficient.

i) Were there any major stumbling blocks, obstacles, frustrations, and problems during implementation? -- Subjective
   (1) If so, what were they?
   (2) What were the factors for the obstacles?
      (a) Overall efficiency of implementation that would allow for eventual implementation of service packages
ii) Did each stage of the process stay within the recommended time limits and not exceeding the time frame as defined by EnPower? -- Objective
   (1) If not, which ones? By how long? What were the major factors in the delay?

b) Stakeholders and community members accept the EnPower process
   i) What were the general attitude and feedback of the community, the individual members, and the other stakeholders during the implementation process? -- Subjective
      (1) Was the feedback positive?
         (a) Gained from observation and conversation
         (b) If not, why? What aspects were 'off-putting'?

Appendix A.3

Information Gathering Criteria Module A (stakeholder relevant criteria):

a) Information collection is complete
  - i) Were question and question topics understood? --Subjective
    - (1) Were the answers given without hesitation, without need for further clarification, without need for repetition of question?
      - (a) Judging the clarity and specificity of questions
  - ii) Were there any specific questions or question topics asked but were not obtained? -- Objective
    - (1) The respondents did not know, could not tell us, translation could not be done, etc.
    - (2) Which ones? Why? - This could partially be subjective.
  - iii) Was there any information needed for analysis but not obtained because it was not required by the data collection stage? -- Objective
    - (1) Note: there will be certain kinds of information that are necessary for completing analysis, but are neither asked for nor is a data entry location for it.

b) The information collected is relevant, useful and used
  - i) Was information required by data analysis (databases, EnPower software)? -- Objective
  - ii) Did the information that was gathered move analysis towards the intended need? -- Objective

Appendix A.4

Information Gathering Criteria Module B (researcher relevant criteria):

c) Collection of information is easy
- i) Did information collection take a reasonable amount of time? -- Subjective
  - (1) Was the amount of time needed to complete the questionnaire reasonable in regards to the length and content of the questionnaire? -- Subjective
    - (a) For example, if the survey was 'long' in the sense of number of questions, but content required quick, short answers; versus if the survey was 'short' in the sense of number of questions, but content required long, elaborated answers.
  - (2) Was the length of time allocated to demand-side research sufficient (2-3 days)?
    - (a) Take into account sample size
    - (b) Take into account cultural differences between interviewer and interviewee: time of day able to collect information, respondents' daily routines, respondents' work schedules, respondents' eating schedules, respondents' religious or social event schedules
  - (3) Take into account average length of time needed to conduct each survey
  - (4) Did interviewees become annoyed with the interviewer?
    - (a) What were the reasons? - This could be partially subjective.
    - (b) Was the reason: the length of the survey?
- ii) Were question and question topics understood? --Subjective
  - (1) Were the answers given without hesitation, without need for further clarification, without need for repetition of question?
    - (a) Judging the clarity and specificity of questions
- iii) Were there helpful guidelines for the interviewer that gave additional insight or advice into better data collection? -- Subjective
- iv) Were there any specific questions or question topics that required unnecessary and additional explanation? Which ones? -- Subjective
- v) Were there any specific questions or question topics that were difficult to obtain the answers for? Which ones? -- Subjective
- vi) Were the respondents unwilling to give information on a specific questions or question topics? -- Subjective
  - (1) It is possible that some information was inappropriate to ask for, so the respondent was reluctant/unwilling to participate on a specific topic or they gave false information (which we may not be able to discern).
- vii) Was the order of data collection consistent within the questionnaire? – Objective
  - (1) Looking at one subsection of a section to the next, were data columns consistent?

d) Respondents are willing to give information on specific questions or question topics
- i) Were there any questions or question topics that resulted in hesitation by the respondent? -- Subjective
  - (1) If so, which ones?
- ii) Were there any questions or question topics that seemed to offend respondents? -- Subjective
  - (1) If so, which ones?

Appendix A.5

Computer Software and Tools Criteria Module (CSTSM)

a) Data entry was and efficient
   i) Did data entry take place in a reasonable amount of time? – Subjective
      (1) Dependent upon the level of data entry skills of the person entering the information
   ii) Was data entry process confusing? -- Subjective
   iii) Was data entry efficient? Was time wasted in moving from one area to another? -- Subjective
   iv) Were there a high number of errors in data entering? It may not be the user's fault; it may be a design flaw. -- Objective
      (1) Dependent upon the level of data entry skills of the person entering the information
   v) Were data entry forms easy to find data fields after data entry? -- Subjective
      (1) Can data fields be found quickly, not more than a minute?
   vi) Was it easy to go back in the data entry forms or spreadsheets to check data entry work? -- Subjective
      (1) Can data fields be found quickly, not more than a minute or dependent upon how far back the user needs to go?
   vii) Were there any software execution errors? -- Objective
      (1) Software, calculation defects. How many? What were they specifically?
   viii) Do the software or data entry forms have helpful messages: explanations, guides, and 'how to' sections? -- Objective
   ix) Does the user always have a quick reference guide if confused? -- Objective
   x) Are data entry forms or spreadsheets easy to read? -- Subjective
      (1) Based on design aesthetics. Cognitive psychology of computer software design.
   xi) Was the order of data entry consistent? -- Objective
      (1) Within the Software/database sheets?
      (2) Between the questionnaire and Software/database sheets?
b) Data entry transferring was easy
   i) Were there any computer execution errors during the exportation? -- Objective
      (1) How many? What were they specifically?
c) Data analysis through EnPower software was easy and efficient
   i) Was using the EnPower software easy? – (Use Designing the User Interface (3rd Edn.), by Ben Shneiderman, published by Addison Wesley Longman, 1997 as a guide for these design specifics.)
      (1) User friendliness:
         (a) Aesthetics affects ease of use. Were there any formatting or certain layouts that were displeasing to the eye of the user, which can affect the efficiency and accuracy of the use of the tool?
      (2) Was there an appropriate amount of white space? (Cognitive psychology of computer software design.)
      (3) Were spacing and placing of input boxes, text boxes, message boxes, buttons, scrollbars, and text labels appropriate? (Cognitive psychology of computer software design.)
      (4) Were colors, text fonts, and text sizes appealing, inoffensive, appropriate? (Cognitive psychology of computer software design.)

(5) Were there helpful text boxes, hints, ‘how to’ messages that can improve efficiency in use of software, also allows user to know what to do next?

(6) Were there helpful labels for input boxes to help in knowing what is suppose to go in the input box?

ii) Were there human errors, such as data entry or selection of desired process (i.e. specific button click)? -- Objective

(1) If there are a high number of human errors, it may not be the user’s fault, but possibly the poor design of the software - Poor design can include any of the above user-friendliness specifics.

(a) How many? In which areas were errors found?

Appendix B:
Changes made during EnPower implementation

APPENDIX B

Changes made during EnPower implementation:

Individual Household Survey:

The first change we made to the Individual Household Survey was in Section 2.4. Originally the question asked for the specific education levels of the household members, instead of this we modified the level of detail of this question and only asked for the number of household members who could read and write. Since this question is only pertinent to demographics and is only useful in making decisions on how to later disseminate information to the community, changing this question did not take away from EnPower's outputs. Comparing the first few interviews that were conducted using the original question and the subsequent interviews using the modification, we found that with the modification that particular section consumed less time.

The second change that we included in the survey was made in Section 3 of the Individual Household Survey. This section requires information on the household's energy usage. The modification that we incorporated was to break down the method of asking the respondents about the amount of time they spent cooking in a day. Instead of using the original method of asking outright the amount of time spent cooking, we first asked the respondents how many meals they cooked, followed by how long each meal took to cook. This method took the burden off of the respondent of calculating the number of hours and was easier for the respondents to think of the number of hours spent cooking each meal. Making it easier for the respondent also increased the efficiency of this section of the questionnaire because the respondent did not have to spend additional time in summing the hours.

A third and similar modification to the one just mentioned was made to Section 5.2 of the Individual Household Survey, which asked the respondents for their expenditure percentages. We modified the question by asking how much the household actually spent on each of the categories, since the respondents were more familiar with the actual totals spent on each category than with percentages. With the expenditure amounts and the total household incomes, we were later able to calculate the percentages ourselves. Since it was easier for the respondents to calculate their expenditures in this manner, the collection of this information was more efficient. This modification also proved beneficial when validating a household's monthly income. Based upon the household's monthly expenditures, we were able to crosscheck and verify their monthly income.

Appendix C:
Results and Analysis

Appendix C
Section I:

EnPower Results and Analysis

The EnPower Toolkit outlines five sequential steps and provides the tools for completing the EnPower Process. To evaluate the EnPower process we sequentially completed these five steps including Initialization; Situational Analysis; Detailed Investigation and Data Gathering; Calculation and Basket Development, and Presentation to Stakeholders. The first two steps were intended to set-up the project and familiarize the implementing parties with the area to be studied. The Data Collection Phase, Step 3, was further broken down into three sub-phases: Stakeholder Research, Supply Side Research and Demand Side Research. The Data Analysis and Basket Generation phase followed this and the last step was to present the outcomes, termed "baskets," to the stakeholders involved and allow them to decide upon the most appropriate "baskets". Before evaluating the process of obtaining the EnPower outputs, it is important to be aware of the actual results. The steps that most affect the basket generation are the Situation Analysis, the Individual Household Survey and the Group Meeting Interview, which have been summarized below. Also, the actual EnPower baskets are described to complete the scope of the process.

Step 1 & 2: Situational Analysis

Steps 1 and 2, the Initialization and Situational Analysis steps, focused on familiarizing ourselves with the site of our project, two informal settlements within the Khomas Region of the Okuryangava district, more specifically, the neighborhoods of Okahandja Park and Ongulumbashe. These two neighborhoods encompass approximately 300-400 un-electrified households and are located north of Windhoek. These two areas are distinguished from other informally settled areas surrounding Windhoek because they share a common church that provides some community structure. In addition, Okahandja Park is currently in the process of being formalized by the municipality. Efforts by the city have started to create formalized plots so that utilities may one day be provided such as grid connections and a sewer system (Hugo Rust, personal communication, March 25, 2003). The situational analysis provided us with an introductory insight into the geographical location, types of current energy usage and the socio-economic structure of the community.

Our situational analysis consisted of two visits to the informal settlements, first on the morning of March 19th, 2003, and again on the evening of March 25th. Upon our initial visit we were able to meet Vicar Cloete of the Gaswobe Evangelical Lutheran Church, constructed in 2001 on the hillside overlooking Okahandja Park. Among other things, he was able to confirm our assumptions stating that the church offers the most directed formalized structure in the community (Vicar Cloete, personal communication, March 19, 2003). We also learned that, with a parish of approximately 1,000 worshipers, the church has a considerable influence in the community. From the Situational Analysis we were also able to find out that there is a high unemployment rate that is responsible for the community's low financial state.

Upon our second visit we were able to gain a better idea of the energy usage in the community. Like other informally settled areas, the estimated 1,500 residents in Okahandja Park and Ongulumbashe depend heavily on traditional energy fuels, like firewood, to cook their food, heat their homes and provide light after sunset. We were told that the church choir, for example, holds practices around an open fire to provide light to read songbooks and that the church holds bible studies around fires (Vicar Cloete, personal communication, March 19, 2003). People also use fires as a gathering place to have conversations and spend time with family and friends. In addition to traditional energy sources, we found that the community also has some access to modern energy sources as demonstrated by the solar powered telephone booths that were recently installed by the municipality and by a diesel generator used by the Gaswobe Evangelical Lutheran Church, which was unfortunately stolen.

Step 3: Data Collection

The Detailed Investigation and Data-Gathering step, Step 3, uncovered the information needed to understand the community's situation and develop appropriate "baskets". This was conducted in three parts: Stakeholder Research, Supply Side Research, and Demand Side Research. The Stakeholder Research identified possible stakeholders, the Supply Side Research identified the available fuels and appliances for a community and the Demand Side Research investigated the needs of community members and how they used energy. The findings from these three sub-phases are further discussed in more detail below.

Stakeholder Research

The Stakeholder Research phase was aimed at identifying all possible stakeholders in the EnPower process. For our project the identified stakeholders were the residents of Okahandja Park and Ongulumbashe, Vicar Cloete, Pastor Petrus of the Gaswobe Evangelical Lutheran Church and the municipality of Windhoek, more specifically the Office of Community Development, the Office of Sustainable Development and ___. They were ranked, according to their respective influence in the community, in the following order: ___.

Supply Side Research

The Supply Side Research phase identified the available fuels and appliances for a community. We were able to reuse most of the previously gathered information from the case study conducted in Okamapuku, Namibia, in February of 2003 in regards to the costs, supply options and lead times because of its proximity to Okuryangava as well as the limited suppliers of the various fuels and appliances.

Demand Side

Our Demand Side Research incorporated an Individual Household Survey as well as a Group Meeting Interview. This research was aimed at investigating how energy is used and identifying the needs of community members. The household questionnaire provided information regarding individual households and their energy usage, whereas the group preference questionnaire provided collective opinions on fuels, services, and the relative importance of various energy issues, also know as dimensions, such as cost and reliability. The information gathered from the group questionnaire represents the community's overall preferences in regard to these categories.

Individual Household Survey

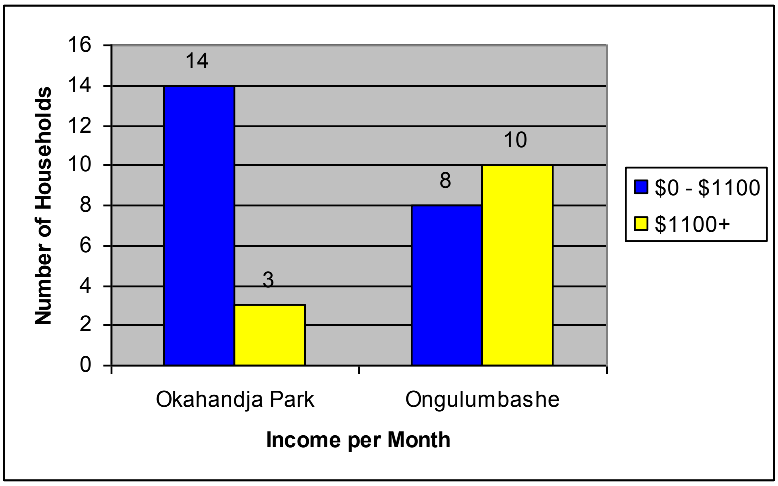


Figure 1: Household Income Levels in Okahandja Park & Ongulumbashe

We conducted our Individual Household Survey on the afternoon of March 26th, 2003, and the morning of the 27th, 2003. From the 36 surveys conducted, we were able to gain information regarding individual households in terms of biographical, energy usage and socio economic data. The biographical information concerned household details, household composition, household income and literacy rate of household members. We were able to establish a division of household income levels as depicted in Figure 1. The average household income in our sample was approximately N$1100 with almost all of the sampled population earning less than N$3,000 a month. As represented in the chart, Okahandja Park had slightly more low-income households. In regards to the number of medium income households Ongulumbashe has significantly more then Okahandja Park.

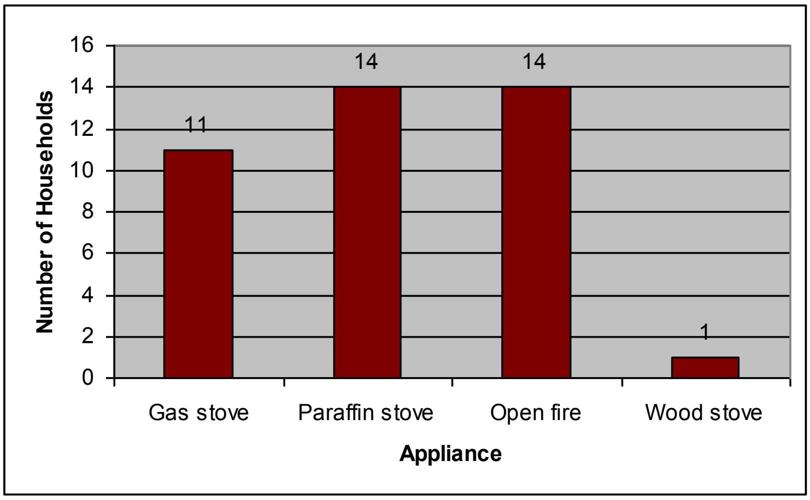


Figure 2: Appliances Used for Cooking in Okahandja Park & Ongulumbashe

To assess energy usage in the community we looked at both the types of appliances used and the amount of time each household spent doing various energy requiring activities. These activities included cooking, water heating, ironing cloths, lighting and listening to the radio or TV. As seen in Figure 2, there were four appliances used for cooking, of which a gas stove, paraffin stove and an open fire were most common. Data regarding the other activities can be found in Section II of this appendix.

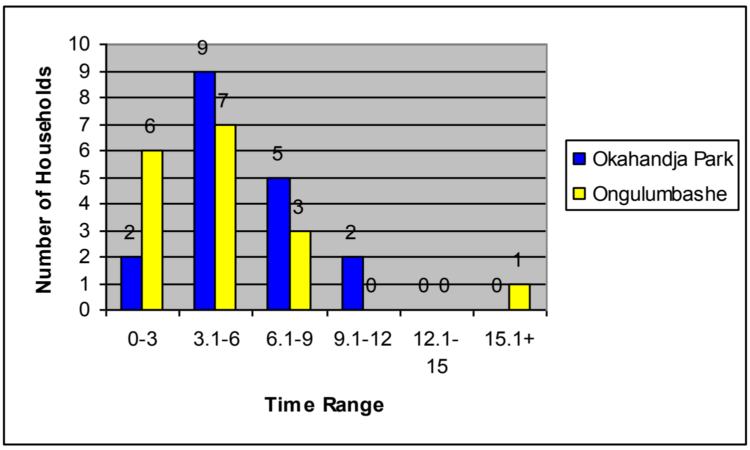


Figure 3: Plate Hours Spent Cooking in Okahandja Park & Ongulumbashe

From this, we were able to go further and determine the average amount of time spent cooking each day. These results are depicted in Figure 3. Based upon this bar graph, it can be estimated that most families spend between three and six plate hours cooking each day. Plate hours are dependent upon how many and how long plates are used during a meal's preparation. For example, if three plates are used for one hour to prepare a meal, the meal requires three plate hours.

The third part of the survey still focused on energy, but more specifically it focused on the sources of fuels used in the community. For example, fuels like paraffin or firewood can be bought at local stores, at the village store or even at a store in another village. According to our surveys, more than two-thirds of the population purchased their fuels at "local stores" like shebeens, whereas almost all of the remaining third supported the "village store" (which we classified as market places and other formal establishments) with their fuel purchases. Figure 4 represents this. Furthermore, looking closely at the "local stores," we examined the different types of fuels they sold. As seen in Figure 5, paraffin is the leading type of fuel sold, closely followed by candles with firewood in third place.

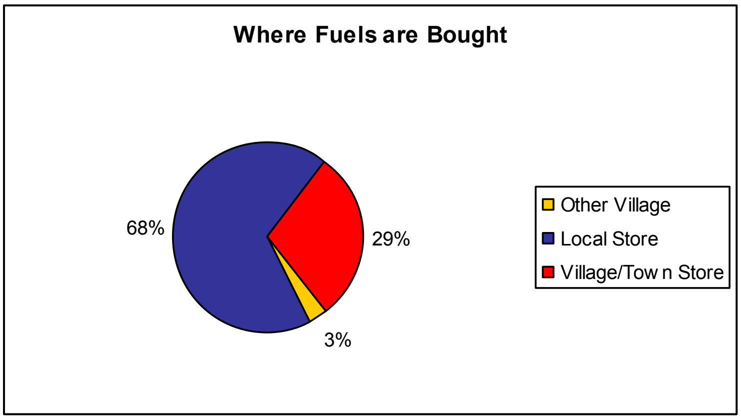


Figure 4: Where Fuels Are Bought

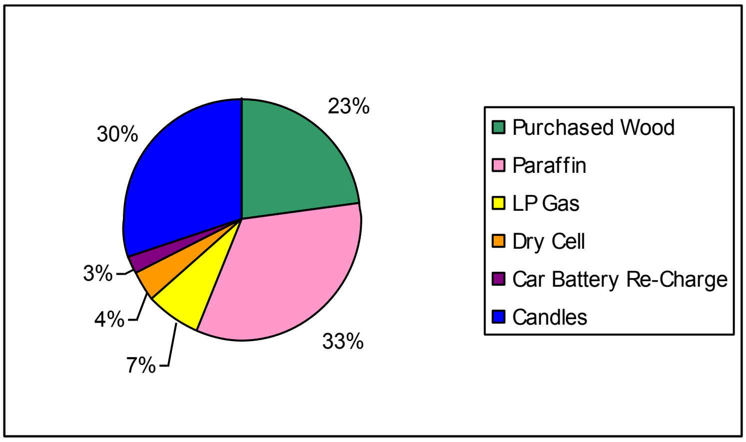


Figure 5: Types of Fuel Purchased at "Local Stores"

Once we determined the types of fuels community members were purchasing and where they were purchasing them, we looked at the reasons determining why they purchased the fuels at those particular locations. We found that almost two-thirds of the population chose to purchase their fuels at a particular location because of its "convenience", while the other third was almost evenly divided between "lower price" and "no choice." See Figure 6. We did find, however, that the numbers for the overall selection of "no choice," was highly influenced by reasons for purchasing fuels in both "other villages" and at "village stores." This is mainly because some of the fuels purchased by community members, like LP Gas, are only available at these other locations.

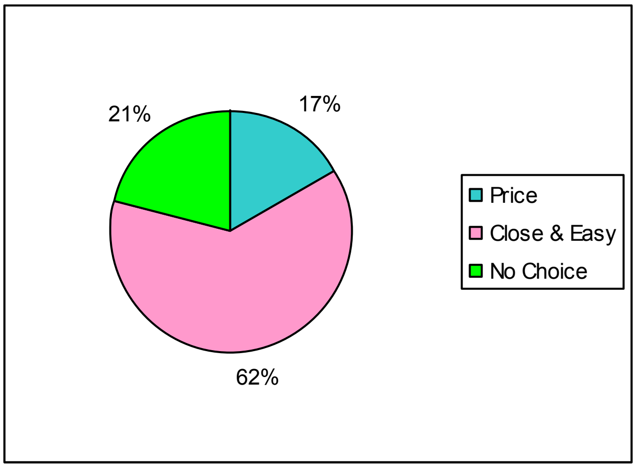


Figure 6: Reasons for Location for Fuel Purchase in Okahandja Park & Ongulumbashe

To finish off the survey we gathered information regarding community members' aspirations for future improvements to either the community or their homes or both. To do this we asked them to pick the top three things they would like to see improved. The results can be seen in Figure 7. “Energy” and “water” were chosen most frequently with “house” as a close third.

To gain a better understanding of an individual household’s priority in income expenditure we obtained information on the amounts of money spent on different categories, which include food, education, taxi transportation fees, water utility charges, and fuel and appliance costs. As detailed in Figure 8, it is apparent that half of their monthly income is spent on food, twenty-percent is spent on fuel and appliance costs while the remaining thirty-percent is divided among education, transportation and service fees. To further explore these data, we broke them down into income level brackets and found that the overall data are representative of both the low and middle-income levels. The only significant difference is that middle-income level households have a noticeably higher percentage of income spent in the other category. This difference is most likely due to shebeens, which spend large amounts of income on supplies for their business. See Part II of this appendix for more details.

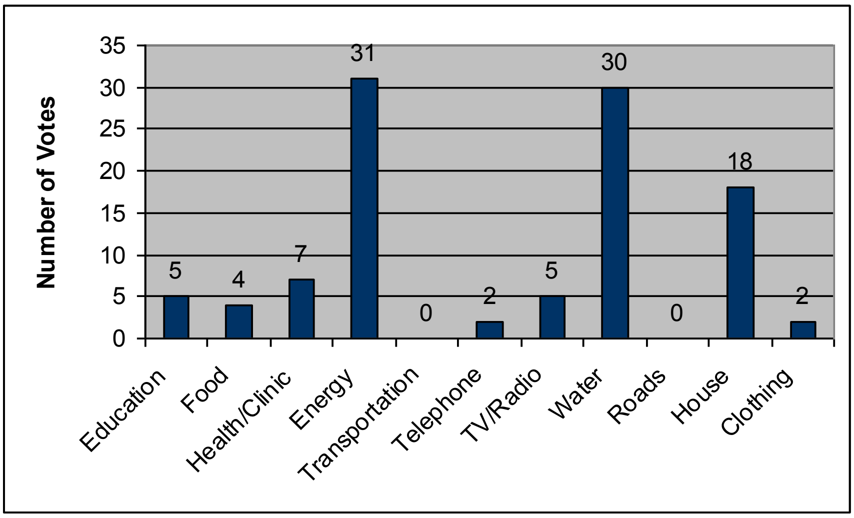


Figure 7: Top Three Improvement Imperatives

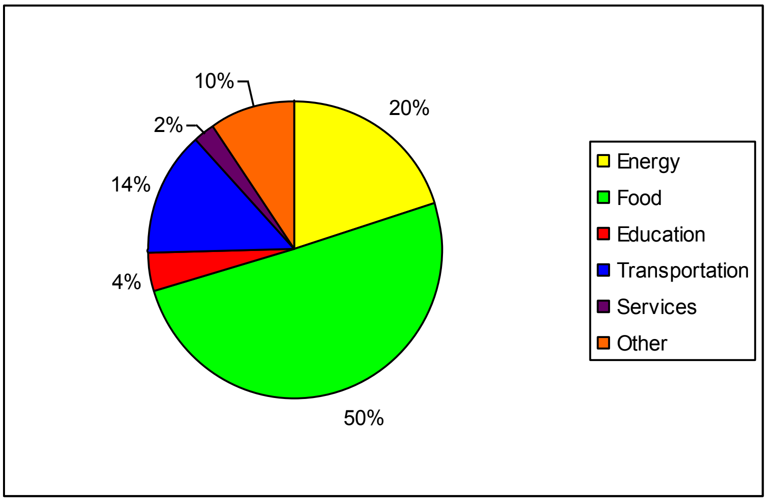


Figure 8: Expenditures for Households in Okahandja Park & Ongulumbashe

Group Meeting Interview

We conducted the Group Meeting Interview at the Gaswobe Evangelical Lutheran Church on the evening of April 9th, 2003. The purpose of the group interview was to gather opinions regarding fuels, services and the relative importance of energy issues in order to assemble a general preference ranking of these categories. The details of the ranking can be found in Appendix <D>.

The fuels we considered included paraffin, LP gas, wood (open fire), wood (wood stove), charcoal, solar, and legal grid electricity. Some of these fuels ranked higher or lower, depending on what service we were focusing on. For example, LP gas ranked 2nd for cooking, yet 5th for refrigeration/freezing. Reasons for this preference ranking might include cost and convenience. For services like cooking, lighting, and space heating the fuels often ranked from electricity (preferred), LP gas, paraffin, wood, and charcoal last. When applicable, solar ranked 2nd or 3rd, after electricity, for services like water heating and refrigeration/freezing. As a rule though, electricity always came out first and, and when appropriate, charcoal last.

The second half of the Group Meeting Interview concerned a preference ranking of energy issues like affordability, appearance, convenience, safety and reliability. In general, “affordability” ranked as the highest priority, with “convenience” and “safety” in second and third places, respectively. When talking about lighting, it was interesting to note the result of the comparison of “safety” and “appearance.” Although it did not affect the final ranking, we found it interesting that the “appearance” of light fixtures was considered more important than their “safety.”

Step 4: Basket Generation

Based upon the data gained during the Data Collection phase, and with the help of the EnPower software, we were able to generate “baskets.” There were three sets of baskets, one for each income level.

Appendix C
Section II:
The following charts and graphs supplement Section I of this appendix.

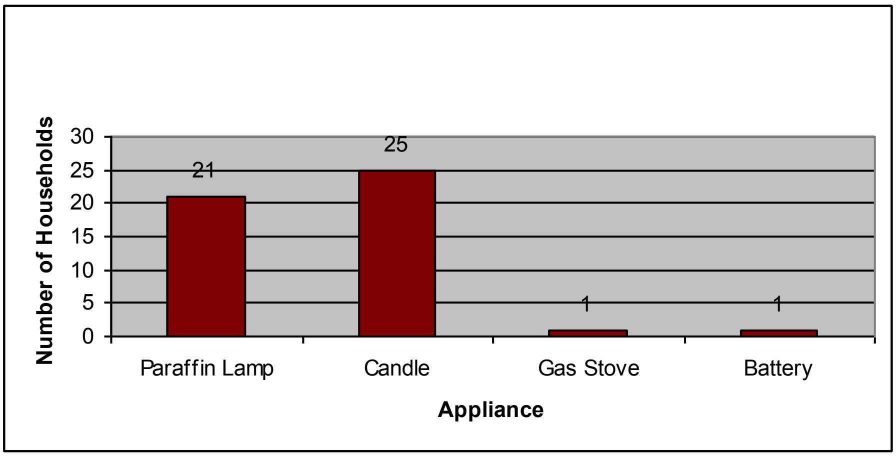


Figure 9: Appliances for Lighting in Okuryangava

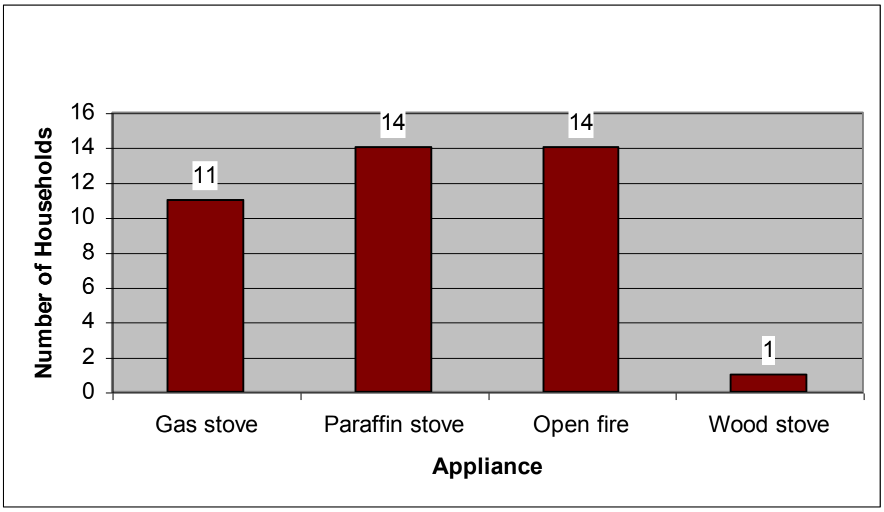


Figure 100: Appliances for Water Heating in Okuryangava

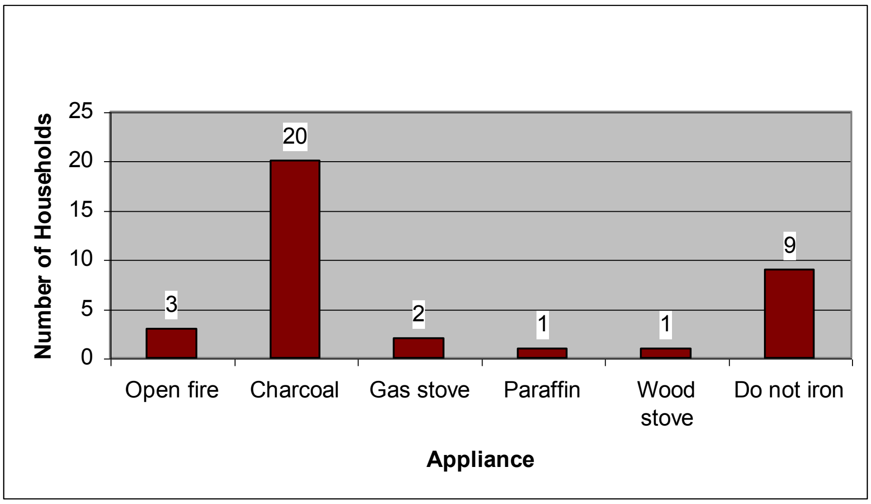


Figure 11: Appliances Used for Ironing in Okuryangava

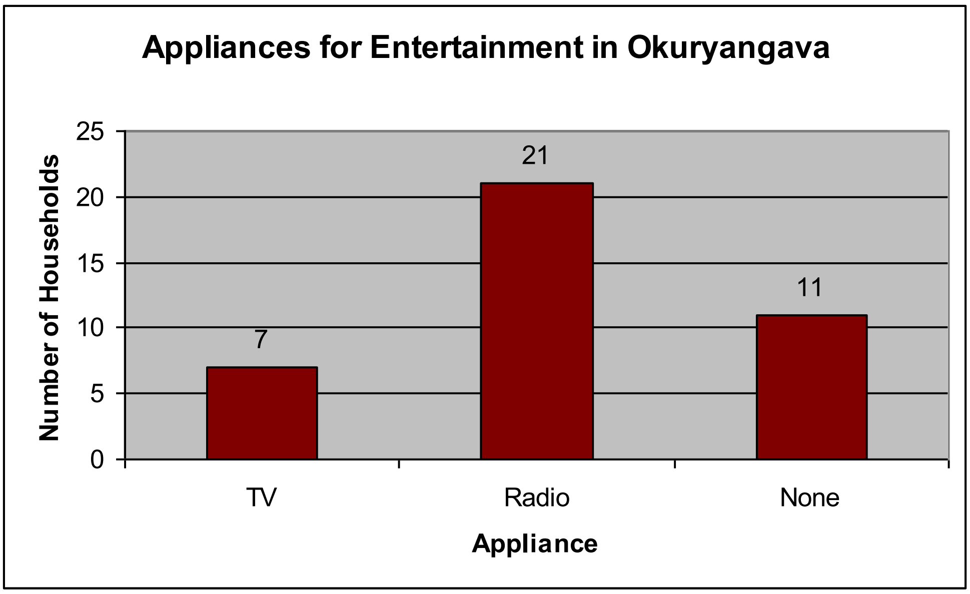


Figure 111: Appliances for Entertainment in Okuryangava

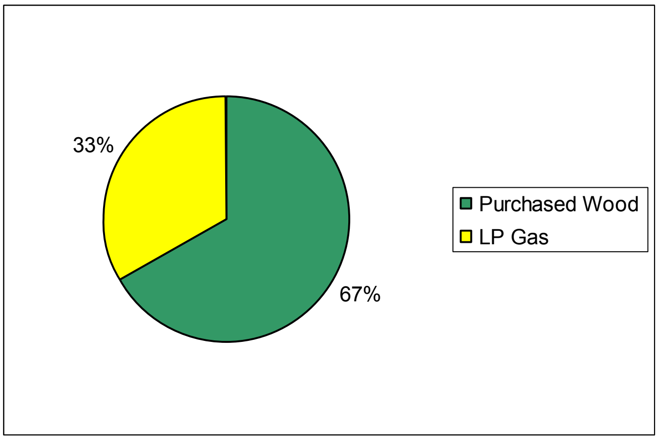


Figure 112: Types of Fuels Purchased in "Other Villages"

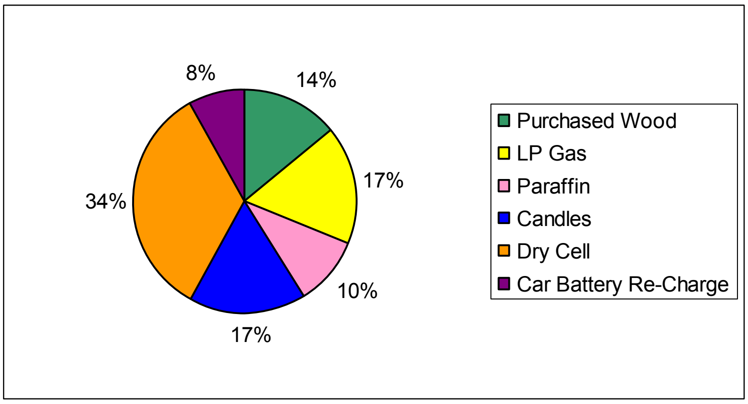


Figure 113: Types of Fuel Purchased in "Village/Town Stores"

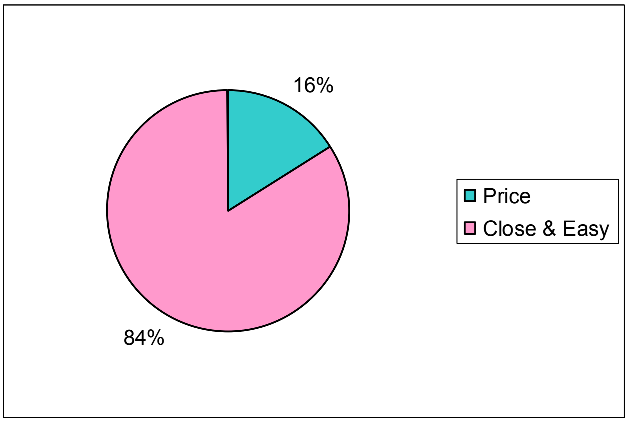


Figure 114: Reasons for Location of Fuel Purchase at "Local Store"

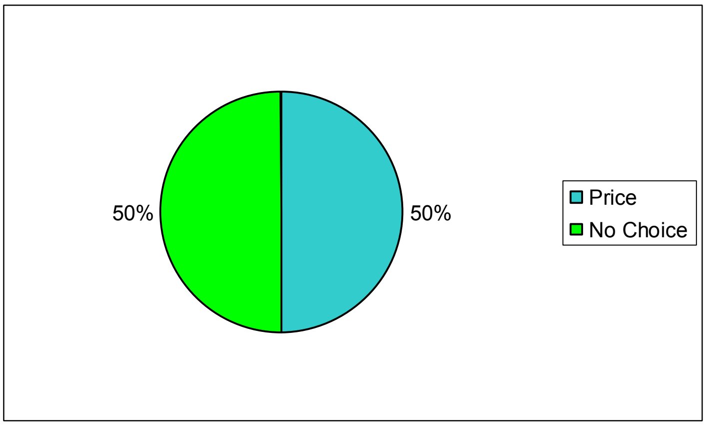


Figure 115: Reasons for Location of Fuel Purchase at "Other Village"

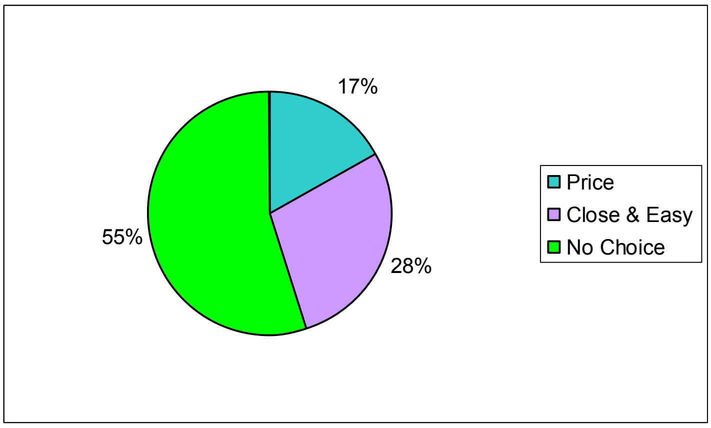


Figure 116: Reasons for Location of Fuel Purchase at "Village/Town Stores"

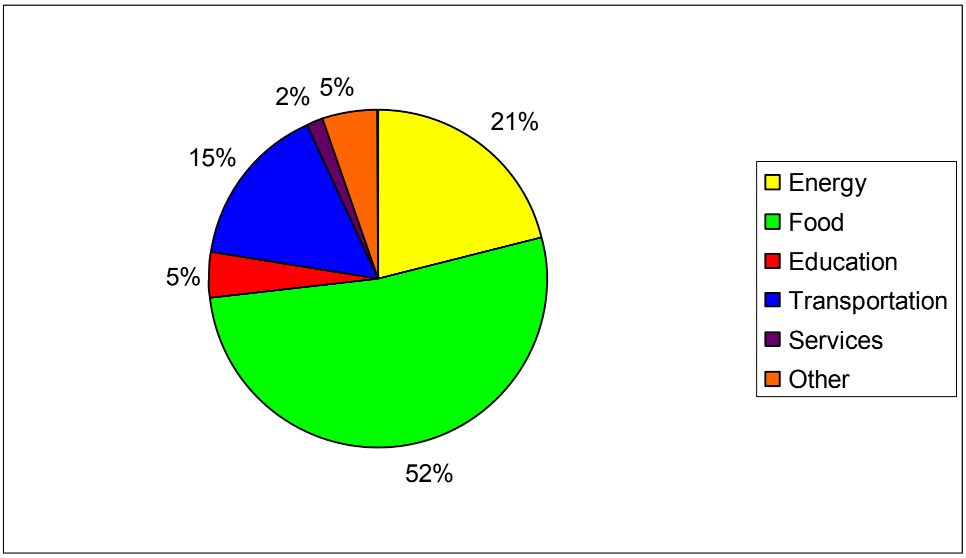


Figure 117: Expenditures for Low Income Households in Okuryangava

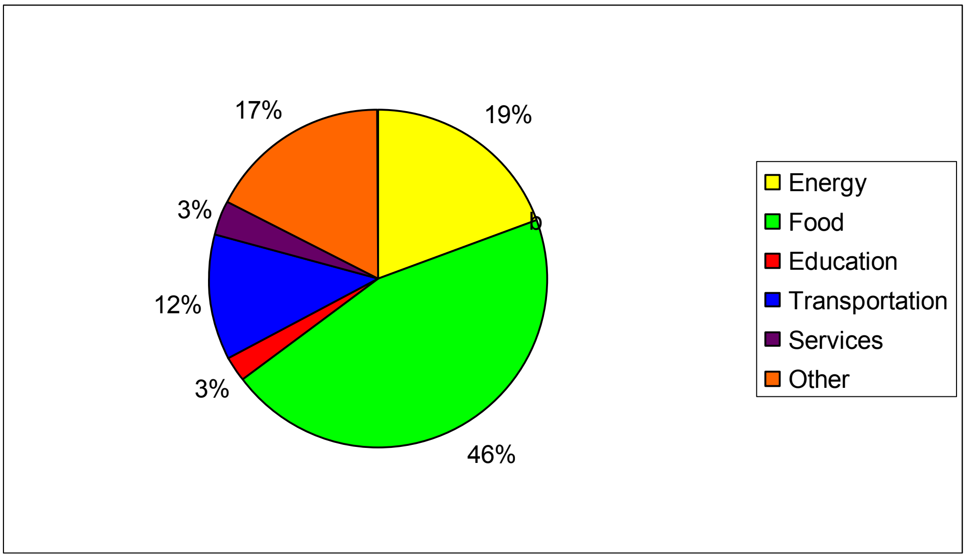


Figure 118: Expenditures for Middle Income Households in Okuryangava

Appendix D:
R-3-E Demand Side
Group Meeting Questionnaire

ENPOWER TOOLKIT
DEMAND SIDE
GROUP INTERVIEW GUIDELINES

The purpose of community meetings/interviews is to inform the population about energy research and understand the common views held within the community.

This exercise will ask questions about different types of fuels and how they are used to supply different services. The community will rank and score different combinations. This will tell you how they prioritize their energy needs. The EnPower Algorithm will help you analyse these results.

Group interviews are often powerful and efficient, but often neglected in favour of individual questionnaire-based interviews. Group interviews are a way to check information gathered during the individual household surveys, as one will get fairly accurate information during group sessions. People will 'police' each other to respond accurately. (EnPower Toolkit, 2003, G5 - Ch. 3.5 p. 9)

Follow the basic guidelines already outlined in the EnPower Manual. The important difference that this method provides is that the community only needs to view two choices at a time in order to come to one decision. The burden of knowing all the different options at one time is taken off of the respondents.

Provide visuals for the fuels so that the respondents have a better understanding of what you are referring to. For the fuel dimensions, be ready to give examples of the concepts that the respondents need to decide upon.

Steps for paired comparison:

1. First explain the purpose of the meeting and what the outcome at the end is.
2. Give the instructions to the respondents on the fuel preferences:
    a. "We will be looking at one energy service (what you do with energy) at a time."
    b. "We will be looking at two fuels at a time for that service." (Display the pictures of the fuels that you are having the respondents consider. It will be most helpful to do so.)
    c. "Then we will allow you to vote on which fuel you prefer more."
    d. "If you have any questions feel free to ask."
3. Give the instructions to the respondents on fuel dimension preferences:
    a. "We will be looking at one energy service (what you do with energy) at a time."
    b. "We will be looking at two 'dimensions' at a time for that service."
    c. (Now you need to explain what a 'dimension' is. We have given some suggestions.) "A dimension is something that you consider when you go out and buy fuel. For example, do you look at only the price or do you look at how well the fuel is going to work for what you want to do with it?" (Specifics can be replaced in this suggestion.)
    d. "Next, we will allow you to vote on which 'dimension' is more important to you."
    e. "If you have any questions, feel free to ask."
4. Thank everyone for their cooperation and patience.

Remember that there are important guidelines included in the manual that should be followed. Patience is one example that is important to remember. Carefully review what has been outlined in the EnPower manual.

Good luck.

ENPOWER TOOLKIT
DEMAND SIDE GROUP QUESTIONNAIRE

Village ______________________ Date___________
Researcher(s)__________________ Time___________

Part A. Ranking of fuel preferences

Compare one fuel at a time for each of the services that are listed. Score each fuel by adding up the number of 'wins.' Rank fuel preferences according to the amount of 'wins.'

Cooking	Paraffin	LP Gas	Wood/Waste	Wood Stove	Charcoal	Solar Cooker	Grid Electricity	Score	Ranking
Paraffin									
LP Gas									
Wood/ Waste									
Wood Stove									
Charcoal									
Solar Cooker									
Grid Electricity									

Lighting	Paraffin	LPG	Candles	Batteries/Grid Electricity	Photo-Voltaic	Petrol / Diesel	Score	Ranking
Paraffin								
LPG								
Candles								
Batteries/Grid Electricity								
Photo-Voltaic								
Petrol / Diesel								

Heating Water	Paraffin	LPG	Solar Water Heater	Wood/ Waste	Wood Stove	Grid Electricity	Score	Ranking
Paraffin								
LPG								
Solar Water Heater								
Wood/ Waste								
Wood Stove								
Grid Electricity								

Ironing	LPG	Charcoal	Grid Electricity	Heated iron	Score	Ranking
LPG						
Charcoal						
Grid Electricity						
Heated iron						

Space Heating	LPG	Charcoal	Wood/ Waste	Wood Stove	Grid Electricity	Score	Ranking
LPG							
Charcoal							
Wood/ Waste							
Wood Stove							
Grid Electricity							

Refrigeration/ Freezing	Paraffin	LPG	Grid Electricity	Photo Voltaic	Petrol / Diesel	Score	Ranking
Paraffin							
LPG							
Grid Electricity							
Photo Voltaic							
Petrol / Diesel							

TV/Radio	Batteries	Grid Electricity	Photo-Voltaic	Petrol / Diesel	Score	Ranking
Batteries						
Grid Electricity						
Photo-Voltaic						
Petrol / Diesel						

Part B. Ranking of service dimension preferences

Compare one dimension at a time for each of the services that are listed. Score each dimension by adding up the number of 'wins.' Rank dimension preferences according to the amount of 'wins.'

Cooking	Reliability/ Maintenance	Safety & Health	Appearance - Space & Size	Convenience - Versatility	Better Cooking	Affordability - Replacement Value	Score	Ranking
Reliability/ Maintenance								
Safety & Health								
Appearance - Space & Size								
Convenience - Versatility								
Better Cooking								
Affordability - Replacement Value								

Lighting	Superior Brightness	Appearance	Safety	Convenience/ Maintenance	Affordability	Score	Ranking
Superior Brightness							
Appearance							
Safety							
Convenience/ Maintenance							
Affordability							

Heat Water	Convenience - Versatility, Rapidity	Safety	Capacity	Affordability	Score	Ranking
Convenience - Versatility, Rapidity						
Safety						
Capacity						
Affordability						

Ironing	Rapidity	Convenience/ Versatility - Ease of Use	Cleanliness	Safety	Affordability	Score	Ranking
Rapidity							
Convenience/ Versatility - Ease of Use							
Cleanliness							
Safety							
Affordability							

Space Heating	Warmth	Convenience - Versatility	Safety	Modernity	Affordability/ Running Costs	Score	Ranking
Warmth							
Convenience - Versatility							
Safety							
Modernity							
Affordability/ Running Costs							

Refrigeration & Freezing	Safety	Size	Affordability - Fuel Availability	Score	Ranking
Safety					
Size					
Affordability - Fuel Availability					

Appendix E:
Group Meeting Questionnaire Visual Aids

Appendix F: Recommendations for EnPower

APPENDIX F

Recommended changes to the EnPower:
Both DCT and Algorithm software

Notes for Data Collation Tool:

Overall:

- General suggestion on the ability to export or import individual questionnaires. It would allow for more concurrent data entry to occur, allowing for time efficiency (especially if there is a large number of households surveyed).
- There should be "Comments" or "Notes" text boxes at the end of each data entry (each questionnaire) to allow for anything that should be noted but there was no data entry input field. There could be special case situations that should be electronically documented (through the DCT).
- Allow for DCT super-user database capabilities
    - When trying to enter in fuel consumptions for paraffin space heater and a gas stove used for baking, those appliances were not available for selection by the data entry person.

All pages:

- text box with 'help' ('Guidance') message should be read only. Users can delete the text without meaning to.
- The placement of the "Next" button (and 'back' button as well) are not consistent from screen to screen, making it time consuming to have to reposition mouse to scroll through the data pages. Suggestion: make the data entry forms all the same size so that the coordinates of the buttons are in the same locations when the next page is loaded onto the screen.
- There should be a "Back to Main Menu" button on all data entry pages

Data Entry page #1:

- It was good to see that a helpful pop-up message appeared to indicate when an incorrect input type was attempted. (i.e. when text was entered into number only field). This is a good form of data entry error checking during the process, not after.

Data Entry page #2:

- Member fields: 'Aunt', 'Friend', 'Other', in general need more options
- Activity field: 'Business', 'Other', 'Student', ' Mechanic', in general need more options
    - For activity field: there is a "Cleaner at health clinic". Why is this activity so specific to health clinic? What about cleaners in general (custodian-type positions)?
- Maybe the input field should allow for the users to enter their own activity or have an 'Other' option.
- The Activity drop down box options are either too specific, or too general; at times, the option is not there at all and should be.

Data Entry page #3 (Appliances):

- Refrigerator volume: is that all that is available?
- Better ordering of appliances, maybe by the group (fuel type), then from that grouping: alphabetical.
- Specifically for "Wood fire (open)":
    - the baking service automatically has '1 liter' assigned to it. The default value should be zero.
- For any of the hot water services (under any appliance): the 'Qty', 'Unit' columns do not seem to make sense. Is it supposed to mean the amount of water heated at one time, and the next two columns indicate the total amount of water for one day? Why the repetition? Maybe there should be more clarification on what each column is asking for.
- 'High power electric light 20 W CFL' is inconsistent with other light appliances, such as candle holder and paraffin lamp. The 'General lighting', 'Close lighting' are switched. In fact, from the old version it has 'Close lighting' first then 'General lighting.' Then in the new version 'General lighting' is before 'Close lighting' in all except the high power electric light 20W CFL. Was there a reason for the switch?
- From one appliance selection to the next, the services listed under each should be consistent (going from appliance to appliance).
- The 'Qty' column rounds; is it suppose to? Is accuracy and precision lost due to rounding? Will calculations be affected? Maybe it is better if there was no rounding of figures so that imprecise calculations can be avoided.
- For the cooking appliances: Why is there is a "Medium heat", instead of the "Mixed settings" option for plate cooking?
- For any appliances that have 'baking' as a service, the unit is 'liter' but the quantity is fixed at '1'. Does that mean only one 'oven', so liter should be changed? Or should it actually be the internal size of the oven in liters?

Data Entry page #4 (Present service use):

- Grammar for text label should be "… currently has BUT not necessarily …"
- TV/radio is not listed. Some people do have these appliances but cannot run them because electricity is unavailable.

Data Entry page #5 (4.1):

- Order of fuels is different from survey form that was printed out. If the format were the same, entering the information would be more efficient.
- The revised format for fuels seems more agreeable. The columns are no longer as confusing as before. However, we should have been made aware of this new version. It may have been possible that the new version could have better aided us in our data collection.
- Unit costs should maintain 2 decimal places for aesthetics, and show the user more clearly that monetary values are desired.
- Do the units for unit cost mean for one of those units? What if the unit is 9kg but it still only has /kg for unit cost? Does that mean the cost of the 9kg fuel needs to be divided by 9kg to get the cost for $$/1 kg? Even with the revised edition of the User Manual for DCT along with the new version of DCT, it is still unclear and confusing as to what each

column of information desires. This might affect the cost of the fuel that the household spends on each month. Suggestion: The User Manual needs to be clearer and give examples as to what is desired for each of the fuels listed.
- This table does not take into account wood that has been collected, and the costs associated with that (taxi, etc).
- Why does the text label for the table say "Thermal fuels"? Are these fuels only supposed to be thermal fuels? Then, why is electricity included?

Data page #6 (4.2: Fuel sources and preferences):
- There is no text label for the "Guidance" text box. There should be.
- Maybe the list of fuels should be listed alphabetically. If this is done for 4.2, then the 4.1 list should also be alphabetized.
- Maybe there should be a "Quality" reason; several people had given that answer for the question of their reason for purchasing fuel from a particular location.

Data page #7 (5: Socio economic drives):
- There is no text label for the "Guidance" text box.
- For 5.2: Maybe the percentages of expenditure are too difficult to ask for or figure out during the interviews. Maybe it is easier to ask for how much money is spent on each category (as we did), and then later calculate the estimated percentages. The entire expenditure percentages can only give rough estimates. This is what we had implemented during our research.
- For 5.2: There is strange auto-formatting of expenditure percentages that takes a little more time to fix or reenter. For example, if a number is entered, the number is taken as a whole number, so 20 ends up as 2000%. Sometimes the decimal number format appears. It depends on how the user enters the text box, whether by clicking, highlighting, or moving arrows up and down. There might not be any way to fix this, but it has been noted as an annoyance.

Data page #8 (5.3):
- Maybe force only 3 'check' marks. This will enforce that there are no data entry mistakes. Maybe if the user attempts to put more than 3 check marks, there should be an error message indicating so, and that the user needs to first undo one of the check marks before marking another.

Notes on the report generation for the DCT:
- "Demographic Averages" (for entire sample size): The "Improvement Imperative Averages" section are incorrect, in that there are no percentages at all but rather zeroes and ones. This may be due to calculation errors. It is interesting to note that the "Improvement Imperative Averages" in "Demographic Averages" for the low and medium income levels, are correct.
- In looking at the "Individual Questionnaire" reports, the dates on these reports do not show the appropriate date. There might be a formatting issue in which the text box that the information resides in, is not large enough, and therefore one of the numbers is cut off.
- In looking at the "Fuel Averages" reports for each of the income level brackets, the "Average Cost" column does not seem to make sense. We are not sure if that cost is suppose to be the cost

of the fuel per month for that amount of fuel. If that is the case, then the values do not seem to be correct. Maybe there should be a description of how the figures were derived.

Notes for User Manual for Data Collation Tool:

Thus far:

- There seem to be many typing or grammar errors that need to be caught. Too many to list, but an example is on page 3 where “1.1 Thermal Fuels” should be “5.1 Fuels”; also, “12V Battery unity cost” should be “12V Battery unit cost”. This comment applies for the entire new version of the EnPower Manual.
- Data entry pages and their section numbers alluded to in the User Manual do not match up with the data entry pages and their section numbers on the actual DCT software.
- On the new version of the survey printout for Individual Household Survey, the section numbers are not in order.
- There need to be more details in describing how to use the DCT in the User Manual. The User Manual refers the user to look at the “Guidance Notes” located in the DCT. However, the DCT “Guidance Notes” were not sufficient. Maybe for each of the data pages, each part of the data entry should be described in more detail as to what is needed. The User Manual for the EnPower Algorithm is more detailed than what the DCT User Manual offers.

EnPower Algorithm software usage notes:

Overall:

- There should be a "back to home page" or "go to end" button. Traversing all of the different pages was difficult when most of the information was already correct but there were minor changes at a specific page needed. For example, all of the information for income demographics and income scenarios were correct but the basket section needed to be modified; however, the user had to traverse through all pages. Another possibility is to have a drop down menu for the user to traverse from section to section, then using the 'back' or 'continue' buttons for moving through pages. This will at least bring people closest to the section they want to work on and then traverse using a finer tool (the 'back' or 'continue' buttons).
- It was helpful that the window sizes were the same so that the positioning of the 'back' and 'continue' buttons were in the same place respective to the computer screen. This allowed for 'fast' traversal through pages, but as mentioned above, the traversal could be expedited.
- There should be a capability for the user to export the reports at the end of an EnPower Algorithm session so that the printing can be more efficiently done.
- Many helpful pop-up windows with error messages; more importantly these error messages (most of which were to indicate incorrect values were entered or insufficient information before continuance) were descriptive so that the user could correct the errors or mistakes.

'Analysis' information section:

- Overall, there were no problems. Easy entry of all information

Demographic information section:

- Importing data from DCT was simple and well explained in user manuals.
- Though we did not use the 'enter own data' option for actual present situation of Okuryangava, we found it helpful to calculate the figures for fuel consumption for specific service requirements. We used these figures to estimate and calculate monthly fuel costs for a given amount of service. With these figures, we validated numbers that EnPower calculated. This will be further discussed in the below sections (basket testing and report generation). In doing this 'enter our own data' part, we noticed a possible defect. When choosing the services used in the present basket on Page 8, if an appliance is chosen with a particular service, then deleted, then that same combination was reattempted, the EnPower Algorithm would not allow this by giving a pop-up error message. It does not seem to make sense that if the combination was deleted that the database would still consider it as a pre-existing combination. The principal of this check (that a combination is not repeated) is correct in what it wants to try, but there is a possibility that the database is not removing the record of a particular combination and still remembers it, even though the user views the combination as being removed.
- Question for Page 4: For the input box "Number of Households," it is unclear why the number of households in which the energy solution is sought for is needed. How does this number affect the solutions that will be proposed?

- Comment: It is indeed much more helpful to have the DCT for data input from the individual household surveys. Doing calculations by hand and then manually entering the numbers and averages would be a time consuming and error-prone process.
- Page 9: This page was the most useful tool that EnPower offered for validity checks because the figures presented show what the households should be using based upon what they report for service use and the fuel amounts that the households report buying. The numbers should correspond before the researcher continues to develop solutions based on those numbers reported. In our analysis, there were many anomalies found on this page for both the low and medium income levels. A lot of time was consumed in correcting these anomalies by going back to the DC T in order to look at the individual fuel consumptions and fuel purchases. This may indicate that, within the data collection process, a lot more validation should be done before information is taken as is from the respondents. These validations should be done while being with the respondent so that the information is as accurate as possible.

Scenario definition section:

- It was extremely helpful to be able to "Copy an existing scenario" because many times the scenarios were similar except for a few additional fuels or appliances. This saved on time and the user only needed to fine-tune the details of a particular scenario.
- Page 14 & 16: It was extremely helpful to have "All Available" and "None Available" buttons to more efficiently select the fuels and appliances available since there might be situations where most of the fuels/appliances are or are not available.
- Page 15: the 'Comments' text input box was extremely helpful so that the researcher could make note of how the numbers were derived in case there were any anomalies in later calculations.
- Page 20: Having the calculations of 'Present use' and 'Expected use' to compare is helpful in developing the minimum service requirements for each of the energy services in the given scenario.
- Page 21: It should be noted that for this page there were fine-tuning adjustments needed because the method for collecting these preferences were different than what EnPower developed. (Note that the ranking is 1-5 with highest being the most preferred choice).

Adjustments:

For 'Hot water': "Better Service" means "Affordability"
For 'Lighting': "Better Lighting" means "Superior Brightness"
"Maintenance" means "Affordability"
For 'Cooking': "Maintenance" means "Reliability"

Suggestion: There was no "Affordability" dimension accounted for by the original EnPower preference ranking. However, in our paired comparison exercise we did include this dimension. Also, all of these preference rankings need to be entered each time a scenario is created. Maybe there should be one data entry point before 'Scenario' definition and possibly before 'Demographic' definition to enter these rankings, since these rankings affect and derive from all of the community.

Basket generation & testing section:

- Choosing baskets combinations were easy and the testing was easy in that the actual steps were straightforward. However, when a basket did not pass, the information on how the basket scored was not entirely precise to aid in troubleshooting. There were still many possibilities that had to be tried in order to discover the reasons in which the basket did not pass. The User Manual for the EnPower Algorithm has suggestions laid out, but still some basket failures did not seem to have clear reasons. For example, in the low income baskets #2, #3, and #4 that we developed, solar box cookers were originally included. However, with this inclusion the baskets did not pass with the failure that the rate of plate cooking was not met. When the solar box cooker appliance was removed, the baskets would pass. It did not seem to make sense that if an additional (extra) cooking plate was offered that the basket would fail. Maybe there needs to be some investigation into this.

- The basket testing proved to be correct. We know this because we were able to calculate (or rather use EnPower's demographic situations) the amount of energy usage that is desired in a basket and compare that to the amount of a basket can provide. We used EnPower's demographic definition section by creating fake demographics with the above-defined situations.
- We noticed that the 'Life-cycle cost' that the EnPower Algorithm calculates does not seem to make sense. We are not sure where the figure is derived from. Maybe a more complete explanation of how the figure was derived would make it more valid and justified. We did not present this figure, even though the concept of the figure would have been helpful, because we were not confident enough that the figure was accurate or correct.
- On this page (Page 23), we suggest that the monthly costs associated with the basket should be included. This way the researcher can know this important figure up front.

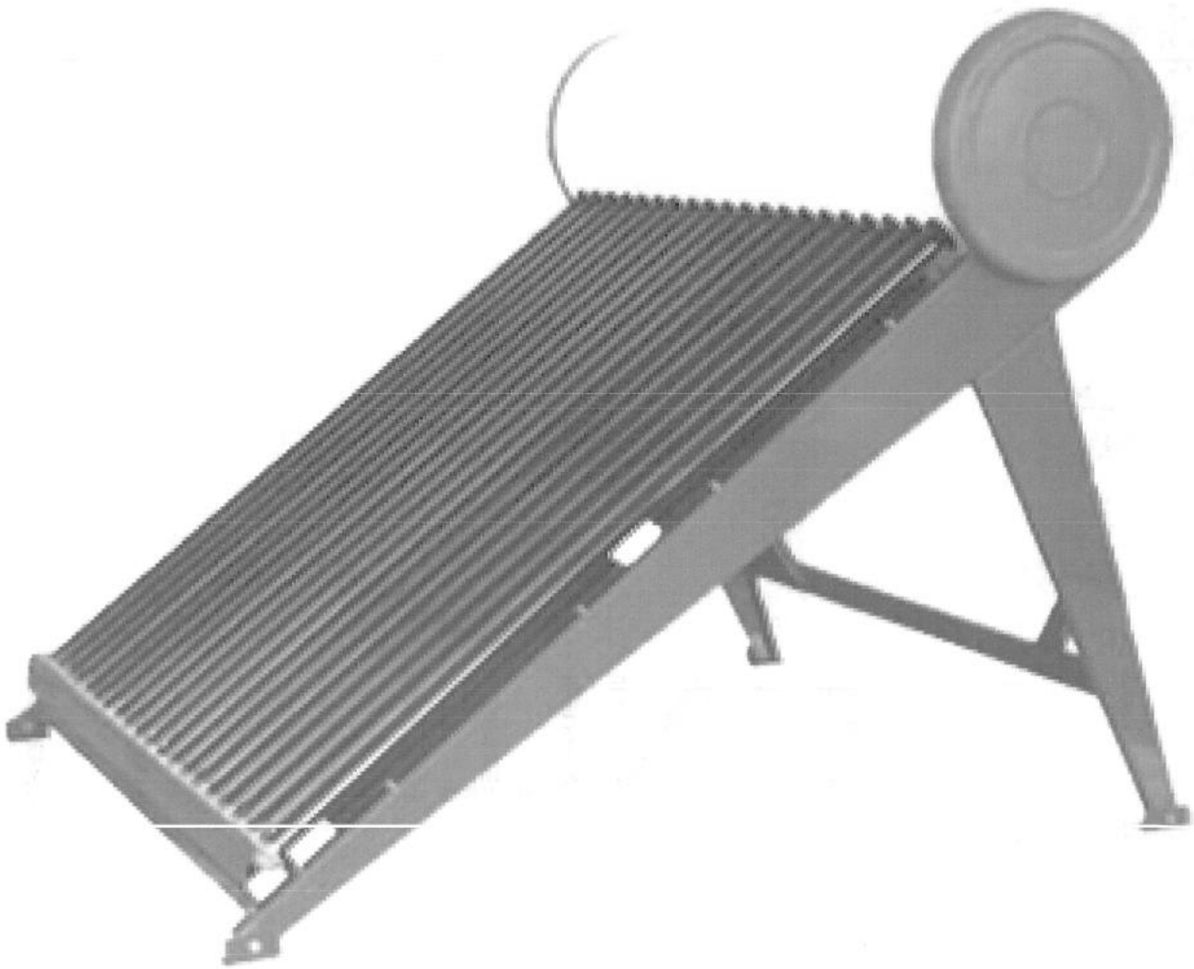
Report generation section:

- We noticed that there might be some error in the report generation. The situation was that we were looking at the reports within the 'comparing baskets' category. Later in the day, we looked at those reports again for referencing and noticed that the charts and information was no longer showing. Upon closing and restarting EnPower Algorithm software, the reports appeared normal again. We are not quite sure why this situation occurs but it should be investigated.
- Another strange behavior was found when looking at the "Basket contents and access cost." Upon looking at that report the first time, the fuel access cost section had accounted for both the national costs and the local costs. This is incorrect in that the national cost served only as a number for the researcher to use as a guide to enter in for the local costs. Essentially, the fuel access costs were being accounted for twice, which is incorrect. The next time that we looked at this particular report, the numbers were correct, and there was no double counting the fuel access cost. We are unsure as to the reasons for this behavior, but this situation must definitely be investigated.
- "Basket contents and access cost" report, maybe this report should also include the monthly fuel cost so that these costs are all located on one report.
- Question: What is the difference between the figures "based on local survey data" and figures "based on EnPower estimates"? Maybe there should be more description in the User Manual describing what these mean and where the figures derived from.
- "Monthly expenditure profile" (report looking at individual baskets): Where do these figures come from? Maybe further explanation in the User Manual may be helpful to the

researcher. We had to derive our own monthly costs since we were not confident with these figures to present to stakeholders.

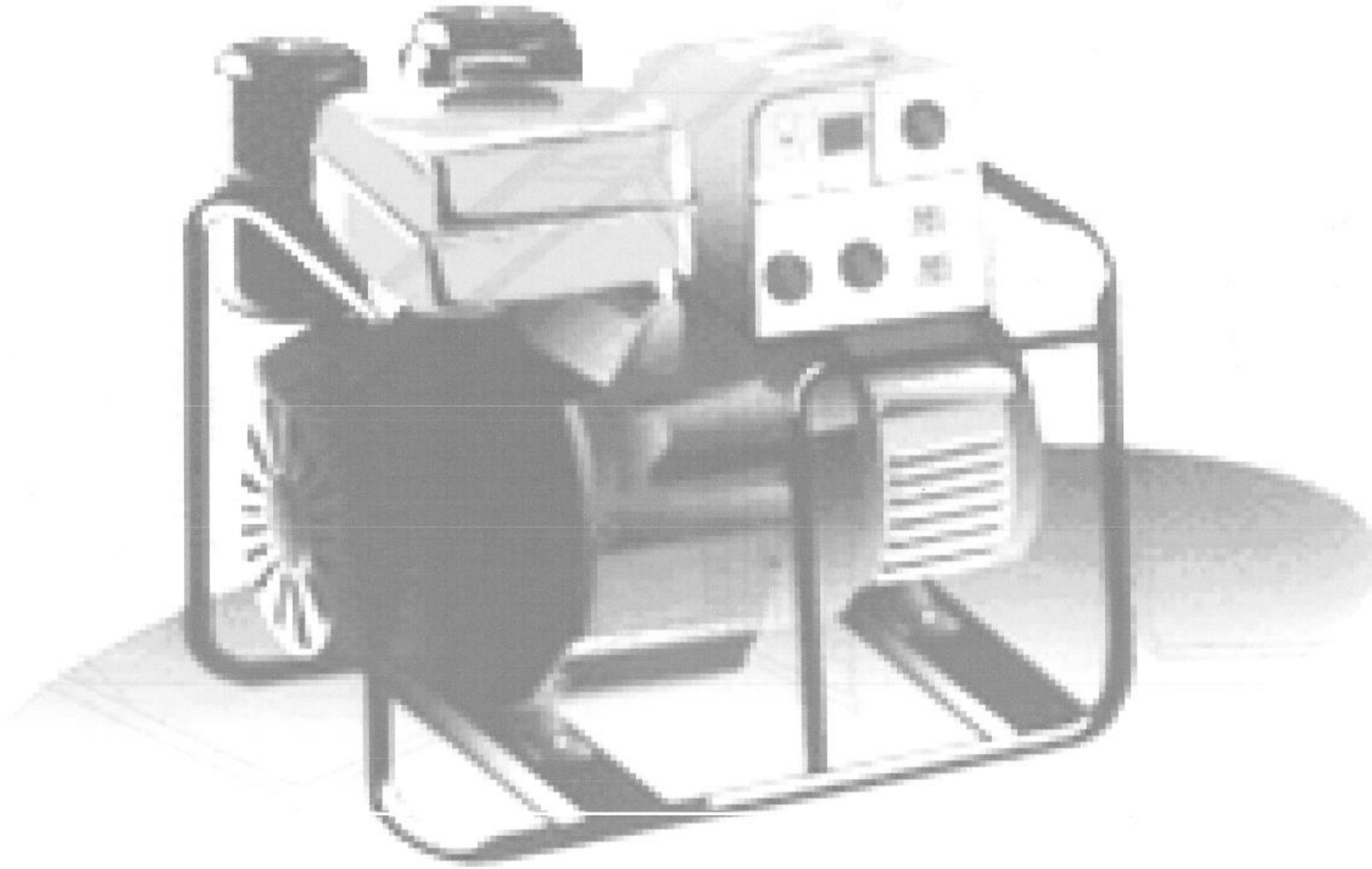
Appendix G:
EnPower Implementation Results

SOLAR WATER HEATER

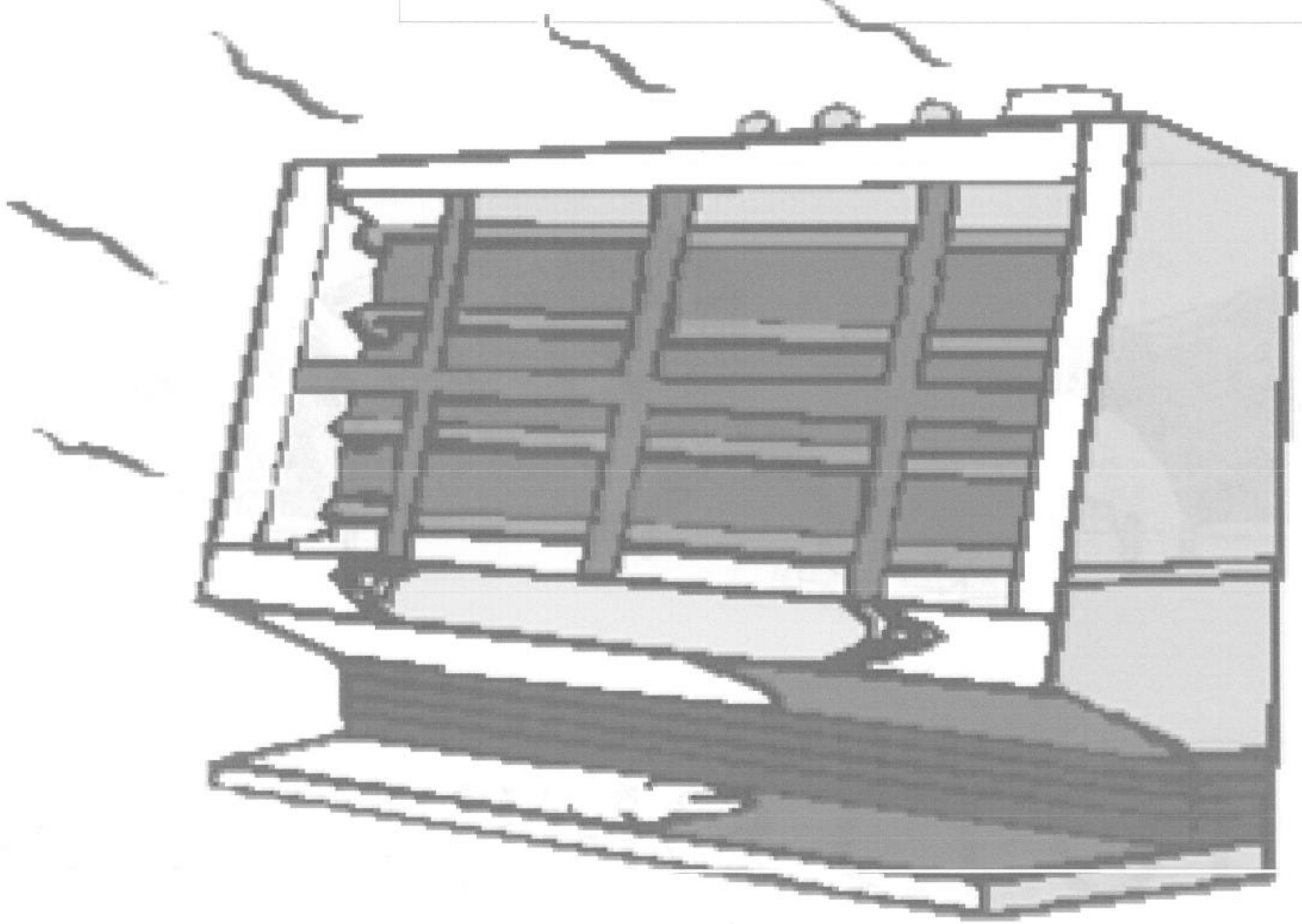


WOOD STOVE

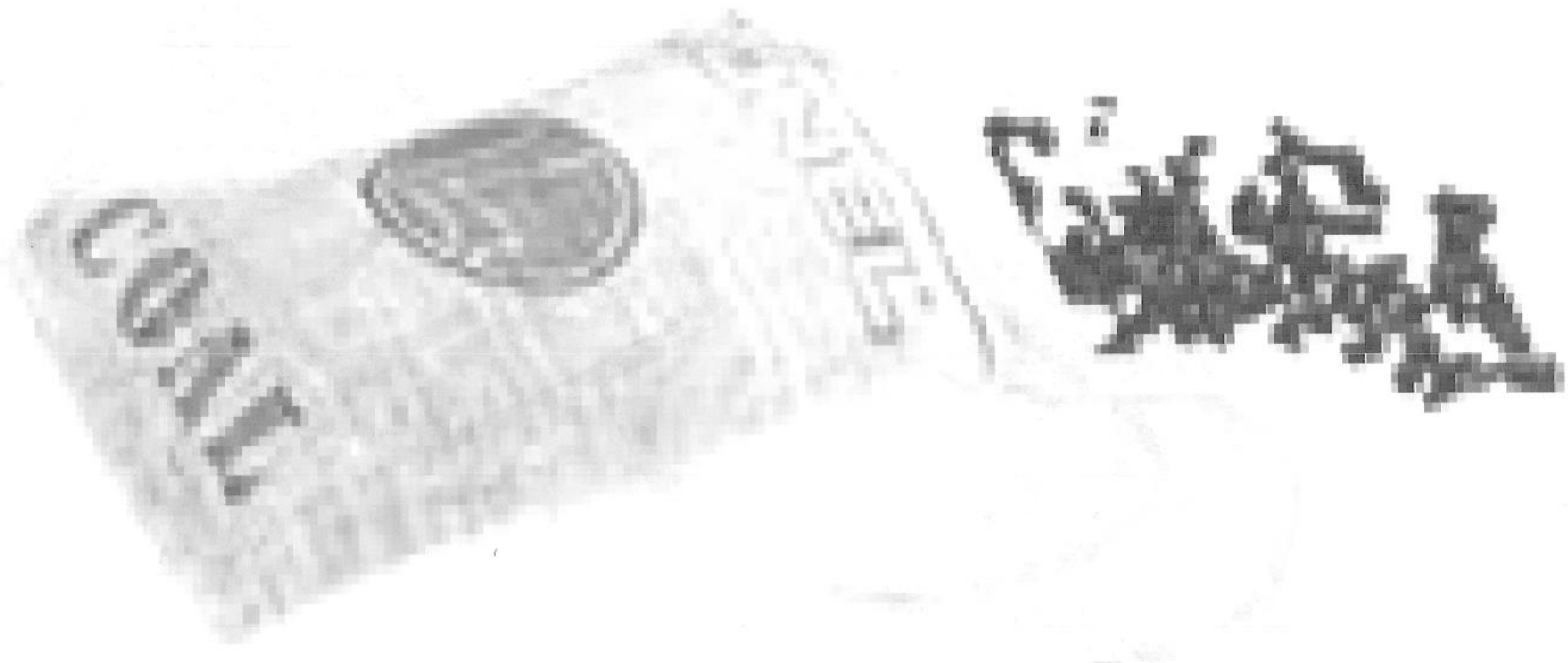
PETROL / DIESEL

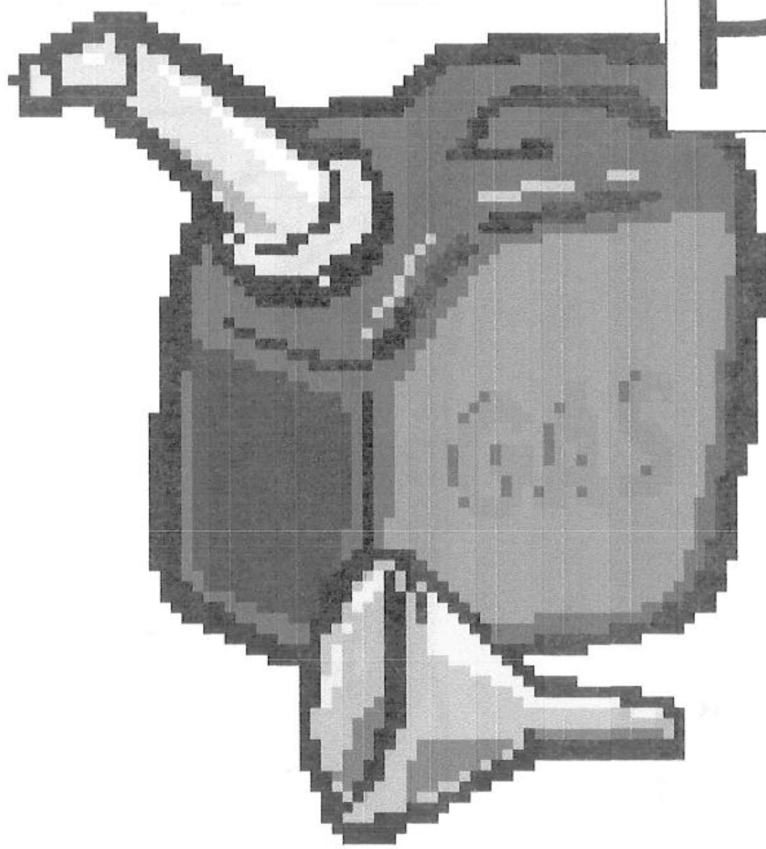


ROOM HEATING



CHARCOAL





PARAFFIN

SOLAR ELECTRIC

Appendix F: Recommendations for EnPower

APPENDIX F

Recommended changes to the EnPower:
Both DCT and Algorithm software

Notes for Data Collation Tool:

Overall:

- General suggestion on the ability to export or import individual questionnaires. It would allow for more concurrent data entry to occur, allowing for time efficiency (especially if there is a large number of households surveyed).
- There should be "Comments" or "Notes" text boxes at the end of each data entry (each questionnaire) to allow for anything that should be noted but there was no data entry input field. There could be special case situations that should be electronically documented (through the DCT).
- Allow for DCT super-user database capabilities
  - When trying to enter in fuel consumptions for paraffin space heater and a gas stove used for baking, those appliances were not available for selection by the data entry person.

All pages:

- text box with 'help' ('Guidance') message should be read only. Users can delete the text without meaning to.
- The placement of the "Next" button (and 'back' button as well) are not consistent from screen to screen, making it time consuming to have to reposition mouse to scroll through the data pages. Suggestion: make the data entry forms all the same size so that the coordinates of the buttons are in the same locations when the next page is loaded onto the screen.
- There should be a "Back to Main Menu" button on all data entry pages

Data Entry page #1:

- It was good to see that a helpful pop-up message appeared to indicate when an incorrect input type was attempted. (i.e. when text was entered into number only field). This is a good form of data entry error checking during the process, not after.

Data Entry page #2:

- Member fields: 'Aunt', 'Friend', 'Other', in general need more options
- Activity field: 'Business', 'Other', 'Student', ' Mechanic', in general need more options
  - For activity field: there is a "Cleaner at health clinic". Why is this activity so specific to health clinic? What about cleaners in general (custodian-type positions)?
- Maybe the input field should allow for the users to enter their own activity or have an 'Other' option.
- The Activity drop down box options are either too specific, or too general; at times, the option is not there at all and should be.

Data Entry page #3 (Appliances):

- Refrigerator volume: is that all that is available?

Data page #6 (4.2: Fuel sources and preferences):

- There is no text label for the "Guidance" text box. There should be.
- Maybe the list of fuels should be listed alphabetically. If this is done for 4.2, then the 4.1 list should also be alphabetized.
- Maybe there should be a "Quality" reason; several people had given that answer for the question of their reason for purchasing fuel from a particular location.

Data page #7 (5: Socio economic drives):

- There is no text label for the "Guidance" text box.
- For 5.2: Maybe the percentages of expenditure are too difficult to ask for or figure out during the interviews. Maybe it is easier to ask for how much money is spent on each category (as we did), and then later calculate the estimated percentages. The entire expenditure percentages can only give rough estimates. This is what we had implemented during our research.
- For 5.2: There is strange auto-formatting of expenditure percentages that takes a little more time to fix or reenter. For example, if a number is entered, the number is taken as a whole number, so 20 ends up as 2000%. Sometimes the decimal number format appears. It depends on how the user enters the text box, whether by clicking, highlighting, or moving arrows up and down. There might not be any way to fix this, but it has been noted as an annoyance.

Data page #8 (5.3):

- Maybe force only 3 'check' marks. This will enforce that there are no data entry mistakes. Maybe if the user attempts to put more than 3 check marks, there should be an error message indicating so, and that the user needs to first undo one of the check marks before marking another.

Notes on the report generation for the DCT:

- "Demographic Averages" (for entire sample size): The "Improvement Imperative Averages" section are incorrect, in that there are no percentages at all but rather zeroes and ones. This may be due to calculation errors. It is interesting to note that the "Improvement Imperative Averages" in "Demographic Averages" for the low and medium income levels, are correct.
- In looking at the "Individual Questionnaire" reports, the dates on these reports do not show the appropriate date. There might be a formatting issue in which the text box that the information resides in, is not large enough, and therefore one of the numbers is cut off.
- In looking at the "Fuel Averages" reports for each of the income level brackets, the "Average Cost" column does not seem to make sense. We are not sure if that cost is suppose to be the cost of the fuel per month for that amount of fuel. If that is the case, then the values do not seem to be correct. Maybe there should be a description of how the figures were derived.

EnPower Algorithm software usage notes:

Overall:

- There should be a "back to home page" or "go to end" button. Traversing all of the different pages was difficult when most of the information was already correct but there were minor changes at a specific page needed. For example, all of the information for income demographics and income scenarios were correct but the basket section needed to be modified; however, the user had to traverse through all pages. Another possibility is to have a drop down menu for the user to traverse from section to section, then using the 'back' or 'continue' buttons for moving through pages. This will at least bring people closest to the section they want to work on and then traverse using a finer tool (the 'back' or 'continue' buttons).
- It was helpful that the window sizes were the same so that the positioning of the 'back' and 'continue' buttons were in the same place respective to the computer screen. This allowed for 'fast' traversal through pages, but as mentioned above, the traversal could be expedited.
- There should be a capability for the user to export the reports at the end of an EnPower Algorithm session so that the printing can be more efficiently done.
- Many helpful pop-up windows with error messages; more importantly these error messages (most of which were to indicate incorrect values were entered or insufficient information before continuance) were descriptive so that the user could correct the errors or mistakes.

'Analysis' information section:

- Overall, there were no problems. Easy entry of all information

Demographic information section:

- Importing data from DCT was simple and well explained in user manuals.
- Though we did not use the 'enter own data' option for actual present situation of Okuryangava, we found it helpful to calculate the figures for fuel consumption for specific service requirements. We used these figures to estimate and calculate monthly fuel costs for a given amount of service. With these figures, we validated numbers that EnPower calculated. This will be further discussed in the below sections (basket testing and report generation). In doing this 'enter our own data' part, we noticed a possible defect. When choosing the services used in the present basket on Page 8, if an appliance is chosen with a particular service, then deleted, then that same combination was reattempted, the EnPower Algorithm would not allow this by giving a pop-up error message. It does not seem to make sense that if the combination was deleted that the database would still consider it as a pre-existing combination. The principal of this check (that a combination is not repeated) is correct in what it wants to try, but there is a possibility that the database is not removing the record of a particular combination and still remembers it, even though the user views the combination as being removed.
- Question for Page 4: For the input box "Number of Households," it is unclear why the number of households in which the energy solution is sought for is needed. How does this number affect the solutions that will be proposed?
- Comment: It is indeed much more helpful to have the DCT for data input from the individual household surveys. Doing calculations by hand and then manually entering the numbers and averages would be a time consuming and error-prone process.
- Page 9: This page was the most useful tool that EnPower offered for validity checks because the figures presented show what the households should be using based upon what they report for service use and the fuel amounts that the households report buying. The numbers should correspond before the researcher continues to develop solutions based on those numbers reported. In our analysis, there were many anomalies found on this page for both the low and medium income levels. A lot of time was consumed in correcting these anomalies by going

- We noticed that the 'Life-cycle cost' that the EnPower Algorithm calculates does not seem to make sense. We are not sure where the figure is derived from. Maybe a more complete explanation of how the figure was derived would make it more valid and justified. We did not present this figure, even though the concept of the figure would have been helpful, because we were not confident enough that the figure was accurate or correct.
- On this page (Page 23), we suggest that the monthly costs associated with the basket should be included. This way the researcher can know this important figure up front.

Report generation section:

- We noticed that there might be some error in the report generation. The situation was that we were looking at the reports within the 'comparing baskets' category. Later in the day, we looked at those reports again for referencing and noticed that the charts and information was no longer showing. Upon closing and restarting EnPower Algorithm software, the reports appeared normal again. We are not quite sure why this situation occurs but it should be investigated.
- Another strange behavior was found when looking at the "Basket contents and access cost." Upon looking at that report the first time, the fuel access cost section had accounted for both the national costs and the local costs. This is incorrect in that the national cost served only as a number for the researcher to use as a guide to enter in for the local costs. Essentially, the fuel access costs were being accounted for twice, which is incorrect. The next time that we looked at this particular report, the numbers were correct, and there was no double counting the fuel access cost. We are unsure as to the reasons for this behavior, but this situation must definitely be investigated.
- "Basket contents and access cost" report, maybe this report should also include the monthly fuel cost so that these costs are all located on one report.
- Question: What is the difference between the figures "based on local survey data" and figures "based on EnPower estimates"? Maybe there should be more description in the User Manual describing what these mean and where the figures derived from.
- "Monthly expenditure profile" (report looking at individual baskets): Where do these figures come from? Maybe further explanation in the User Manual may be helpful to the researcher. We had to derive our own monthly costs since we were not confident with these figures to present to stakeholders.

Appendix G: EnPower Implementation Results

ENPOWER SITUATIONAL QUESTIONNAIRE

1.	Geographic Data	
	Question	***Answer/ Range, source of information, comment***
1.1	Village name	Okahandja Park & Ongulumbashe (3/19/03)
1.2	Village – Other names	
1.3	Village Lat, Long Co-ordinates	
1.4	Boundaries	
1.5	Region, district	Okuryangava district, Khomas Region
1.6	Major town close by & distance	Windhoek; 10km
1.7	Leadership Structure	Vicar Cloete (081-255-8150) - has worked with the community for 8 months Elder: Glasen (sp?) Pastor Petrus: 081 259 6109
1.8	Distance between settlements/communities	Close, overlapping areas
1.9	Distance between houses	1,5-2m → 4,5 m
1.10	Road accessibility	No problem / gravel road
1.11	No. of houses & strata/castes of communities	About 300-400 households, extended families
1.12	People in households	About 1000 people total (average 5 people / household, number includes children)

2.	Energy Related Analysis	
	Question	**Answer/ Range, source of information, comment**
2.1	Wood availability	Mostly collected by women by hand, whenever funds available, at the wood lot south of the church, following Julius Nyerere St.

T5 Stakeholder analysis spreadsheet

	Appliance baskets	Overall score
AA	Low Basket 1	5.16
BB	Low Basket 2	6.02
CC	Low Basket 3	7.49
DD	Low Basket 4	6.84
EE	Low Basket 5	8.23
FF	Low Basket 6	9.42

Community researched
Okuryangava

Date last edited
24-Apr-03

	Stakeholder		Dimension	Weighting	Weighting % check
A	Community	Dim 1	Improvement in living	50%	100%
		Dim 2	Fuel Cost	25%	
	20%	Dim 3	Appliance Cost	25%	
B	GEL Church	Dim 1	Community upliftment	100%	100%
		Dim 2	Christian doctrine		
	30%	Dim 3			
C	Municipality	Dim 1	Community upliftment	50%	100%
		Dim 2	Service delivery	30%	
	40%	Dim 3	Return on investment	20%	
D	MME	Dim 1	Integration with Nat policy	30%	100%
		Dim 2	Rural Energy	30%	
	10%	Dim 3	Community upliftment	40%	
E		Dim 1			0%
		Dim 2			
		Dim 3			
F		Dim 1			0%
		Dim 2			
		Dim 3			
G		Dim 1			0%
		Dim 2			
		Dim 3			
H		Dim 1			0%
		Dim 2			
		Dim 3			

Stakeholder % check	100%

Stakeholder		Appliance baskets		Stakeholder Dimension 1-3 Dimension 1	Dimension 2	Dimension 3	Score
A	Community	Appliance baskets		Improvement in living	Fuel Cost	Appliance Cost	
		AA	Low Basket 1	5	3	8	5.3
		BB	Low Basket 2	6	7	7	6.5
		CC	Low Basket 3	7	10	6	7.5
		DD	Low Basket 4	8	2	3	5.3
		EE	Low Basket 5	9	4	2	6.0
		FF	Low Basket 6	10	9	4	8.3
B	GEL Church	Appliance baskets		Community upliftment	Christian doctrine	0	
		AA	Low Basket 1	5	5	0	5.0
		BB	Low Basket 2	6	6	0	6.0
		CC	Low Basket 3	7	7	0	7.0
		DD	Low Basket 4	8	8	0	8.0
		EE	Low Basket 5	9	9	0	9.0
		FF	Low Basket 6	10	10	0	10.0
C	Municipality	Appliance baskets		Community upliftment	Service delivery	Return on investment	
		AA	Low Basket 1	5	5	6	5.2
		BB	Low Basket 2	6	6	5	5.8
		CC	Low Basket 3	7	8	10	7.9
		DD	Low Basket 4	8	7	3	6.7
		EE	Low Basket 5	9	9	8	8.8
		FF	Low Basket 6	10	10	9	9.8
D	MME	Appliance baskets		Integration with Nat policy	Rural Energy	Community upliftment	
		AA	Low Basket 1	6	5	5	5.3
		BB	Low Basket 2	7	5	6	6.0
		CC	Low Basket 3	10	5	7	7.3
		DD	Low Basket 4	8	5	8	7.1
		EE	Low Basket 5	10	5	9	8.1
		FF	Low Basket 6	10	5	10	8.5
E	0	Appliance baskets		0	0	0	
		AA	Low Basket 1	0	0	0	0.0
		BB	Low Basket 2	0	0	0	0.0
		CC	Low Basket 3	0	0	0	0.0
		DD	Low Basket 4	0	0	0	0.0
		EE	Low Basket 5	0	0	0	0.0
		FF	Low Basket 6	0	0	0	0.0
F	0	Appliance baskets		0	0	0	
		AA	Low Basket 1	0	0	0	0.0
		BB	Low Basket 2	0	0	0	0.0
		CC	Low Basket 3	0	0	0	0.0
		DD	Low Basket 4	0	0	0	0.0
		EE	Low Basket 5	0	0	0	0.0
		FF	Low Basket 6	0	0	0	0.0
G	0	Appliance baskets		0	0	0	
		AA	Low Basket 1	0	0	0	0.0
		BB	Low Basket 2	0	0	0	0.0
		CC	Low Basket 3	0	0	0	0.0
		DD	Low Basket 4	0	0	0	0.0
		EE	Low Basket 5	0	0	0	0.0
		FF	Low Basket 6	0	0	0	0.0
H	0	Appliance baskets		0	0	0	
		AA	Low Basket 1	0	0	0	0.0
		BB	Low Basket 2	0	0	0	0.0
		CC	Low Basket 3	0	0	0	0.0
		DD	Low Basket 4	0	0	0	0.0
		EE	Low Basket 5	0	0	0	0.0
		FF	Low Basket 6	0	0	0	0.0

T5 Stakeholder analysis spreadsheet

	Appliance baskets	Overall score
AA	**Medium Basket 1**	**4.58**
BB	**Medium Basket 2**	**5.82**
CC	**Medium Basket 3**	**6.94**
DD	**Medium Basket 4**	**9.75**
EE		**0**
FF		**0**

Community researched
Okuryangava

Date last edited
24-Apr-03

	Stakeholder		Dimension	Weighting	Weighting % check
A	Community 20%	Dim 1	Improvement in living	50%	100%
		Dim 2	Fuel cost	25%	
		Dim 3	Appliance cost	25%	
B	GEL Church 30%	Dim 1	Community upliftment	50%	100%
		Dim 2	Christian faith	50%	
		Dim 3			
C	Municipality 40%	Dim 1	Community upliftment	50%	100%
		Dim 2	Service delivery	30%	
		Dim 3	Return on investment	20%	
D	MME 10%	Dim 1	Integration with Nat policy	30%	100%
		Dim 2	Rural energy	30%	
		Dim 3	Community upliftment	40%	
E		Dim 1			0%
		Dim 2			
		Dim 3			
F		Dim 1			0%
		Dim 2			
		Dim 3			
G		Dim 1			0%
		Dim 2			
		Dim 3			
H		Dim 1			0%
		Dim 2			
		Dim 3			

Stakeholder % check	100%

Stakeholder		Appliance baskets	Dimension 1	Dimension 2	Dimension 3	Score
			Stakeholder Dimension 1-3			
A Community		Appliance baskets	Improvement in living	Fuel cost	Appliance cost	
	AA	Medium Basket 1	4	5	7	5.0
	BB	Medium Basket 2	6	3	5	5.0
	CC	Medium Basket 3	8	6	2	6.0
	DD	Medium Basket 4	10	9	9	9.5
	EE	0	0	0	0	0.0
	FF	0	0	0	0	0.0
B GEL Church		Appliance baskets	Community upliftment	Christian faith	0	
	AA	Medium Basket 1	4	4	0	4.0
	BB	Medium Basket 2	6	6	0	6.0
	CC	Medium Basket 3	8	8	0	8.0
	DD	Medium Basket 4	10	10	0	10.0
	EE	0	0	0	0	0.0
	FF	0	0	0	0	0.0
C Municipality		Appliance baskets	Community upliftment	Service delivery	Return on investment	
	AA	Medium Basket 1	4	3	8	4.5
	BB	Medium Basket 2	6	5	7	5.9
	CC	Medium Basket 3	8	7	2	6.5
	DD	Medium Basket 4	10	10	10	10.0
	EE	0	0	0	0	0.0
	FF	0	0	0	0	0.0
D MME		Appliance baskets	Integration with Nat policy	Rural energy	Community upliftment	
	AA	Medium Basket 1	9	5	4	5.8
	BB	Medium Basket 2	9	5	6	6.6
	CC	Medium Basket 3	9	5	8	7.4
	DD	Medium Basket 4	10	5	10	8.5
	EE	0	0	0	0	0.0
	FF	0	0	0	0	0.0
E 0		Appliance baskets	0	0	0	
	AA	Medium Basket 1	0	0	0	0.0
	BB	Medium Basket 2	0	0	0	0.0
	CC	Medium Basket 3	0	0	0	0.0
	DD	Medium Basket 4	0	0	0	0.0
	EE	0	0	0	0	0.0
	FF	0	0	0	0	0.0
F 0		Appliance baskets	0	0	0	
	AA	Medium Basket 1	0	0	0	0.0
	BB	Medium Basket 2	0	0	0	0.0
	CC	Medium Basket 3	0	0	0	0.0
	DD	Medium Basket 4	0	0	0	0.0
	EE	0	0	0	0	0.0
	FF	0	0	0	0	0.0
G 0		Appliance baskets	0	0	0	
	AA	Medium Basket 1	0	0	0	0.0
	BB	Medium Basket 2	0	0	0	0.0
	CC	Medium Basket 3	0	0	0	0.0
	DD	Medium Basket 4	0	0	0	0.0
	EE	0	0	0	0	0.0
	FF	0	0	0	0	0.0
H 0		Appliance baskets	0	0	0	
	AA	Medium Basket 1	0	0	0	0.0
	BB	Medium Basket 2	0	0	0	0.0
	CC	Medium Basket 3	0	0	0	0.0
	DD	Medium Basket 4	0	0	0	0.0
	EE	0	0	0	0	0.0
	FF	0	0	0	0	0.0

Appendix G.3: EnPower Supply Side Data: Namibia

ENPOWER TOOLKIT
DEMAND SIDE GROUP QUESTIONNAIRE

Village __Okuryangava________ Date_4/9/2003__
Researcher(s)_WPI EnPower Group Time__7:00pm___

Part A. Ranking of fuel preferences

Compare one fuel at a time for each of the services that are listed. Score each fuel by adding up the number of 'wins.' Rank fuel preferences according to the amount of 'wins.'

Cooking	Paraffin	LP Gas	Wood/Waste	Wood Stove	Charcoal	Solar Cooker	Grid Electricity	Score	Ranking
Paraffin		LPG	P	P	P	P	E	4	3RD
LP Gas			LPG	LPG	LPG	LPG	E	5	2ND
Wood/ Waste				WS	W	W	E	2	5TH
Wood Stove					WS	WS	E	3	4TH
Charcoal						C	E	1	6TH
Solar Cooker							E	0	7TH
Grid Electricity								6	1ST

Lighting	Paraffin	LPG	Candles	Batteries/Grid Electricity	Photo-Voltaic	Petrol / Diesel	Score	Ranking
Paraffin		LPG	P	B/GE	PV	PE	1	4TH
LPG			LPG	B/GE	LPG	PE	3	3RD
Candles				B/GE	C	PE	1	4TH
Batteries/Grid Electricity					B/GE	B/GE	5	1ST
Photo-Voltaic						PE	1	4TH
Petrol / Diesel							4	2ND

Heating Water	Paraffin	LPG	Solar Water Heater	Wood/ Waste	Wood Stove	Grid Electricity	Score	Ranking
Paraffin		LPG	S	P	WS	E	1	5TH
LPG			S	LPG	LPG	E	3	3RD
Solar Water Heater				S	S	E	4	2ND
Wood/ Waste					WS	E	0	6TH
Wood Stove						E	2	4TH
Grid Electricity							5	1ST

Part B. Ranking of service dimension preferences

Compare one dimension at a time for each of the services that are listed. Score each dimension by adding up the number of 'wins.' Rank dimension preferences according to the amount of 'wins.'

Cooking	Reliability/ Maintenance	Safety & Health	Appearance - Space & Size	Convenience - Versatility	Better Cooking	Affordability - Replacement Value	Score	Ranking
Reliability/ Maintenance		R	R	R	B	R	4	1ST
Safety & Health			S	S	S	S	4	1ST
Appearance - Space & Size				C	B	AF	0	4TH
Convenience - Versatility					C	C	3	2ND
Better Cooking						AF	2	3RD
Affordability - Replacement Value							2	3RD

Lighting	Superior Brightness	Appearance	Safety	Convenience/ Maintenance	Affordability	Score	Ranking
Superior Brightness		SB	S	C	AF	1	3RD
Appearance			AP	C	AF	1	3RD
Safety				C	AF	1	3RD
Convenience/ Maintenance					AF	3	2ND
Affordability						4	1ST

Heat Water	Convenience - Versatility, Rapidity	Safety	Capacity	Affordability	Score	Ranking
Convenience - Versatility, Rapidity		CO	CA	A	1	2ND
Safety			CA	S	1	2ND
Capacity				A	2	1ST
Affordability					2	1ST

Appendix G.5: EnPower Data Collation Tool Reports: Okuryangava, Namibia

Individual Questionnaire

Sample Data

Village Name	Reference Number	Date	Researcher
Okahandja Park	OKA1	3/26/03	Erin Dupak

Time Start	Time End	Respondent Name	House Position
3:24 PM	3:52 PM	Christophine	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
2	2	2	4

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Small business owner	800

Education Levels

Level	Number
None	6
Other	4

Individual Questionnaire

Sample Data

Village Name	Reference Number	Date	Researcher
Okahandja Park	OKA2	3/26/03	Justin Osgood

Time Start	Time End	Respondent Name	House Position
3:45 PM	4:05 PM	Rebbeca Xoagux	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
3	6	2	2

Household Income Activity

Member	Activity/SourceType	Amount/Week
Mother	Maid	100
Grandmother	Pensioner	250
Grandmother	Pensioner	250
Grandfather	Pensioner	250

Education Levels

Level	Number
None	12
Other	1

Ap| liance and Energy Service Information

Appli ice	Service	Quantity	Use (hrs)	Use(days per annum)
Candl Holder	General lighting	1	3	52
Paraff lamp - gular	General lighting	1	3.5	313
Gas lc pressu stove ouble	Boiling water any purpose	2	2	365
Gas lc pressu stove ouble	Medium heat	3	1.5	365
Wood e (open)	Ironing	1	3	52
Paraff wick stove ow cost s gle	Rapid heating or frying	1	3.75	90
Low P ver radio	Radio	1	4	365

Pre ent service use

Plate oking	3
Lightir	1
Space eating	1
Hot w er	2
Ironin	1
Media Other Services	1

Fue purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Candl	kg/month	0.432	6	1
Low F ver Elec	Vah/month	30	10	2
LPG	kg/month	9	95	1
Paraff	l/month	2	10	2
Wood	kg/month	8.84	5	4

Fuel source purchase information

Source	Fuel
Local Store	Candles
Local Store	Dry Cell Battery
Local Store	LPG
Local Store	Paraffin
Local Store	Wood

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☑	☐	☐
Village Town Store	☐	☐	☐	☐

Decision makers

Decision Maker	Decision Process
woman/wife/moth	

Improvement imperatives

Improvement Imperative	Imperative
Energy	☑
Water	☑
Housing	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	20.00%
Food	60.00%
Education	3.40%
Transport	20.00%
Services	0.00%
Other	0.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	3	20 **M2**

Individual Questionnaire

Sample Data

Village Name	Reference Number	Date	Researcher
Okahandja Park	OKA4	3/27/03	Erin Dupak

TimeStart	Time End	Respondent Name	House Position
11:45 AM	12:00 PM	Selina Corocuvet	OA12

Household Composition

Adult Males	Adult Females	School Children	Non School Children
0	1	0	0

Household Income Activity

Member	Activity/SourceType	Amount/Week
Daughter	Unemployed	0

Education Levels

Level	Number
Other	1

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Wood fire (open)	Ironing	1	1	52
Paraffin wick stove - low cost single	Medium heat	1	2	365
Paraffin wick stove - low cost single	Boiling water any purpose	1	1	365
Candle Holder	General lighting	1	2	5
Paraffin lamp - regular	General lighting	1	4	313

Present service use

Plate cooking	1
Lighting	1
Hot water	0.5
Ironing	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Candles	kg/month	0.144	1	15
Paraffin	l/month	1	4.5	15
Wood	kg/month	4.42	5	4

Fuel source purchase information

Source	Fuel
Local Store	Candles
Local Store	Paraffin
Local Store	Wood

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Candle Holder	General lighting	1	1.5	365
Wood fire (open)	Ironing	1	1	52
Wood fire (open)	Medium heat	3	1.5	365
Wood fire (open)	Warm washing water	1	20	104
Wood fire (open)	Boiling water any purpose	1	1	365

Present service use

Plate cooking	3
Lighting	1
Hot water	1
Ironing	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Candles	kg/month	0.072	1	30
Wood	kg/month	20	20	2

Fuel source purchase information

Source	Fuel
Other Village	Wood
Village/Town Sto	Candles

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☑	☐	☐	☐
Local Store	☐	☐	☐	☐
Village/Town Store	☐	☑	☐	☐

Decision makers

Decision Maker	Decision Process
father	

Improvement imperatives

Improvement Imperative	Imperative
Energy	☑
Water	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	28.00%
Food	52.00%
Education	20.00%
Transport	0.00%
Services	0.00%
Other	0.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	2	22 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Okahandja Park	OKA6	3/27/03	Erin Dupak

TimeStart	Time End	Respondent Name	House Position
12:27 PM	12:46 PM	Ruth Engelbret	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
3	3	3	2

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Self employed, selling good	475
Mother	Maid	600

Education Levels

Level	Number
None	7
Other	4

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☑	☐	☐	☐
Village/Town Store	☐	☐	☐	☐

Decision makers

Decision Maker	Decision Process
mother	

Improvement imperatives

Improvement Imperative	Imperative
Energy	☑
House	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	16.00%
Food	78.00%
Education	7.00%
Transport	0.00%
Services	0.00%
Other	0.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
2	2	21 M2

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Okahandja Park	OKA7	3/27/03	Justin Osgood

TimeStart	Time End	Respondent Name	House Position
12:50 PM	1:05 PM	Domingo	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
1	1	1	3

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Civil Servant	1200

Education Levels

Level	Number
None	5
Other	1

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Wood fire (open)	Ironing	1	0.5	52
Paraffin stove - wick double plate	Boiling water any purpose	1	6	365
Paraffin stove - wick double plate	Medium heat	3	3	365
Candle Holder	General lighting	1	3	365
Paraffin lamp - regular	General lighting	1	3	365
Low-power *electric* television	Television	1	1.5	365

Present service use

Plate cooking	3
Lighting	2
Hot water	2
Ironing	1
Media & Other Services	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Candles	kg/month	0.432	6	2
Low Power Elec	Vah/month	30	10	5
Paraffin	l/month	5	20	3
Wood	kg/month	0.98	1	4

Fuel source purchase information

Source	Fuel
Village/Town Sto	Candles
Village/Town Sto	Wood

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☐	☐	☐
Village/Town Store	☐	☑	☐	☐

Decision makers

Decision Maker	Decision Process
together	

Improvement imperatives

Improvement Imperative	Imperative
Energy	☑
Water	☑
House	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	15.00%
Food	35.00%
Education	5.00%
Transport	30.00%
Services	5.00%
Other	10.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	1	12 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Okahandja Park	OKA8	3/26/03	Justin Osgood

TimeStart	Time End	Respondent Name	House Position
4:30 PM	4:45 PM	Petronela Bapello	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
1	1	0	0

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Civil Servant	500
Mother	Maid	200

Education Levels

Level	Number
Other	2

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Gas low pressure stove - double	Ironing	1	1	52
Gas low pressure stove - double	Boiling water any purpose	1	1	365
Gas low pressure stove - double	Medium heat	2	3	365
Paraffin lamp - regular	General lighting	1	1	365
Dry cell battery radio	Radio	1	3	365

Present service use

Plate cooking	2
Lighting	1
Hot water	1
Ironing	1
Media & Other Services	1
Baking	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Dry Cell Battery	Vah/month	33.3	18	2
LPG	kg/month	5	30	1

House layout

Number of Structures	Number of Rooms	Total Housed Area
2	4	26 **M2**

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Candle Holder	General lighting	1	2	30
Paraffin lamp - regular	General lighting	2	2	365
Gas low pressure stove - double	Medium heat	2	2	365
Wood fire (open)	Ironing	1	0.25	208
Wood fire (open)	Medium heat	1	1.5	365
Wood fire (open)	Warm washing water	1	1.5	365
Wood fire (open)	Boiling water any purpose	1	2	365
Dry cell battery radio	Radio	1	3	365

Present service use

Plate cooking	4
Lighting	3
Hot water	4
Ironing	1
Media & Other Services	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Dry Cell Battery	Vah/month	33.3	15	3
Candles	kg/month	0.432	1	2
LPG	kg/month	5	45	1
Paraffin	l/month	2	5	2
Wood	kg/month	4.42	5	30

Fuel source purchase information

Source	Fuel
Local Store	Candles
Local Store	Paraffin
Local Store	Wood
Village/Town Sto	Dry Cell Battery

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☑	☐	☐
Village/Town Store	☐	☐	☑	☐

Decision makers

Decision Maker	Decision Process
Shared responsi	Comprimising and discussion

Improvement imperatives

Improvement Imperative	Imperative
Education	☑
Energy	☑
House	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	15.00%
Food	55.00%
Education	3.00%
Transport	25.00%
Services	2.00%
Other	0.00%

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Okahandja Park	OKB4	3/27/03	Yvonne Mok

TimeStart	Time End	Respondent Name	House Position
11:06 AM	11:49 AM	Max Hamulo	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
3	1	0	1

Household Income Activity

Member	Activity/SourceType	Amount/Week
Sister	Small business owner	3600
Brother	Labourer	800
Brother	Civil Servant	750
Brother	Civil Servant	600

Education Levels

Level	Number
Other	5

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Candle Holder	General lighting	1	3	40
Gas lamp (LP 100 CP)	General lighting	1	2.5	365
Paraffin stove - wick double plate	Boiling water any purpose	1	1	365
Paraffin stove - wick double plate	Medium heat	1	1	365
Paraffin stove - wick double plate	Warm washing water	1	1	365
Gas refrigerator (100l)	Refrigerating food	100	24	250
Low Power radio	Radio	1	3	365

Present service use

Plate cooking	1
Lighting	2
Refrigeration	190
Media & Other Services	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Candles	kg/month	0.432	6	1
Low Power Elec	Vah/month	30	20	4
LPG	kg/month	20	200	1
Paraffin	l/month	1	4	15

Fuel source purchase information

Source	Fuel
Local Store	Paraffin
Village/Town Sto	LPG

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	✓	☐	☐
Village/Town Store	☐	☐	✓	☐

Decision makers

Decision Maker	Decision Process
Oldest brother	Some discussion, but direct decision making

Improvement imperatives

Improvement Imperative	Imperative
Energy	✓
TV & Radio	✓
Health/Clinic	✓

Expenditure pattern

Expenditure Type	Expenditure
Energy	10.00%
Food	20.00%
Education	0.00%
Transport	0.00%
Services	10.00%
Other	60.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	2	171 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Okahandja Park	OKB5	3/27/03	Yvonne Mok

TimeStart	Time End	Respondent Name	House Position
11:31 AM	11:47 AM	Timotos	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
2	1	0	1

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Small business owner	600

Education Levels

Level	Number
None	1
Other	3

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Paraffin lamp - regular	General lighting	2	5	365
Gas low pressure stove - double	Warm washing water	1	1	365
Gas low pressure stove - double	Boiling water any purpose	1	1	365
Gas low pressure stove - double	Medium heat	2	2	365
Dry cell battery radio	Radio	1	4	365

Present service use

Plate cooking	2
Lighting	2
Hot water	2
Media & Other Services	1
Baking	20

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Dry Cell Battery	Vah/month	33.3	21.5	3
LPG	kg/month	9	100	1
Paraffin	l/month	1	4.5	5

Fuel source purchase information

Source	Fuel
Local Store	Dry Cell Battery
Local Store	Paraffin
Village/Town Sto	LPG

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☑	☐	☐
Village/Town Store	☐	☐	☑	☐

Decision makers

Decision Maker	Decision Process
Father	

Improvement imperatives

Improvement Imperative	Imperative
Education	☑
Energy	☑
Health/Clinic	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	17.00%
Food	50.00%
Education	0.00%
Transport	30.00%
Services	3.00%
Other	0.00%

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Wood fire (open)	Ironing	1	1	52
Wood fire (open)	Medium heat	2	2	65
Wood fire (open)	Warm washing water	1	4	65
Wood fire (open)	Boiling water any purpose	1	1	65
Paraffin stove - wick double plate	Boiling water any purpose	1	1	300
Paraffin stove - wick double plate	Medium heat	2	2	300
Paraffin stove - wick double plate	Warm washing water	1	4	300
Candle Holder	General lighting	1	3	365

Present service use

Plate cooking	4
Lighting	1
Hot water	5
Ironing	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Candles	kg/month	0.432	6	1
Paraffin	l/month	1	4.5	6
Wood	kg/month	30	25	1

Fuel source purchase information

Source	Fuel
Local Store	Candles
Local Store	Paraffin
Local Store	Wood

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☑	☐	☐
Village/Town Store	☐	☐	☐	☐

Decision makers

Decision Maker	Decision Process
Mother	

Improvement imperatives

Improvement Imperative	Imperative
Energy	☑
Water	☑
House	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	20.00%
Food	45.00%
Education	0.00%
Transport	25.00%
Services	10.00%
Other	0.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	2	15 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONB8	3/27/03	Yvonne Mok

TimeStart	Time End	Respondent Name	House Position
10:36 AM	10:48 AM	Olfrida Gertze	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
3	3	1	2

Household Income Activity

Member	Activity/SourceType	Amount/Week
Mother	Maid	500

Education Levels

Level	Number
None	2
Other	7

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Candle Holder	General lighting	1	5	100
Paraffin lamp - regular	General lighting	1	5	265
Wood fire (open)	Ironing	1	1	52
Wood fire (open)	Medium heat	2	4.5	365
Wood fire (open)	Warm washing water	5	5	365
Wood fire (open)	Boiling water any purpose	2	2	365
Dry cell battery radio	Radio	1	5	365

Present service use

Plate cooking	2
Lighting	2
Hot water	7
Ironing	1
Media & Other Services	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Dry Cell Battery	Vah/month	199.8	30	2
Candles	kg/month	0.432	4.45	1
Paraffin	l/month	1	4.5	2
Wood	kg/month	17.68	5	5

Fuel source purchase information

Source	Fuel
Local Store	Candles
Local Store	Paraffin
Local Store	Wood
Village/Town Sto	Dry Cell Battery

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☑	☐	☐
Village/Town Store	☐	☐	☑	☐

Decision makers

Decision Maker	Decision Process
Mother	

Improvement imperatives

Improvement Imperative	Imperative
Energy	☑
Water	☑
House	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	20.00%
Food	54.00%
Education	2.00%
Transport	20.00%
Services	4.00%
Other	0.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	2	24 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Okahandja Park	OKB9	3/27/03	Yvonne Mok

TimeStart	Time End	Respondent Name	House Position
12:39 PM	12:49 PM	Chico	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
1	1	0	2

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Self employed, selling good	1400

Education Levels

Level	Number
None	3
Other	1

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	3	36 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONA2	3/26/03	Justin Osgood

TimeStart	Time End	Respondent Name	House Position
2:05 PM	2:25 PM	Lady	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
1	1	2	1

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Labourer	1000

Education Levels

Level	Number
None	3
Other	2

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Gas low pressure stove - double	Warm washing water	1	1	90
Gas low pressure stove - double	Rapid heating or frying	4	0.75	56
Gas low pressure stove - double	Boiling water any purpose	3	3	365
Gas low pressure stove - double	Medium heat	3	3	365
Low Power radio	Radio	1	3	104
Low-power electric television	Television	1	3	104
Candle Holder	General lighting	1	1	365
Paraffin lamp - regular	General lighting	1	1	365

Present service use

Plate cooking	4
Lighting	2
Hot water	4
Ironing	1
Media & Other Services	1
Baking	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Candles	kg/month	0.072	1	12
Low Power Elec	Vah/month	30	0	15
LPG	kg/month	9	100	1
Paraffin	l/month	1	4.5	4

Fuel source purchase information

Source	Fuel
Local Store	Candles
Local Store	LPG
Local Store	Paraffin

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☑	☐	☐
Village/Town Store	☐	☐	☐	☐

Decision makers

Decision Maker	Decision Process
Father	

Improvement imperatives

Improvement Imperative	Imperative
Food	☑
Energy	☑
Water	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	20.00%
Food	40.00%
Education	10.00%
Transport	20.00%
Services	0.00%
Other	10.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	2	28 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONA3	3/26/03	Erin Dupak

TimeStart	Time End	Respondent Name	House Position
2:28 PM	2:45 PM	Adolphine	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
1	1	1	4

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Migrant Workers	600

Education Levels

Level	Number
None	3
Other	4

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Candle Holder	General lighting	5	2	365
Wood stove - pressed steel	Ironing	1	1	52
Wood stove - pressed steel	Warm washing water	1	4	52
Wood stove - pressed steel	Medium heat	3	6	365
Wood stove - pressed steel	Baking food	1	5	52
Wood stove - pressed steel	Boiling water any purpose	1	4	365

Present service use

Plate cooking	3
Lighting	5
Hot water	7
Ironing	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Candles	kg/month	0.432	6	4
Paraffin	l/month	1	5	4
Wood	kg/month	8.84	5	40

Fuel source purchase information

Source	Fuel
Local Store	Candles
Local Store	Paraffin
Village/Town Sto	Wood

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Candle Holder	General lighting	4	1	365
Wood fire (open)	Baking food	1	2	52
Wood fire (open)	Simmering	2	4	365
Wood fire (open)	Boiling water any purpose	2	2	365
Dry cell battery radio	Radio	1	4	365

Present service use

Plate cooking	2
Lighting	4
Hot water	2
Media & Other Services	1
Baking	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Dry Cell Battery	Vah/month	33.3	16	3
Candles	kg/month	0.144	1	15
Wood	kg/month	4.42	5	30

Fuel source purchase information

Source	Fuel
Village/Town Sto	Candles
Village/Town Sto	Dry Cell Battery
Village/Town Sto	Wood

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☐	☐	☐
Village/Town Store	☐	☑	☐	☐

Decision makers

Decision Maker	Decision Process
grandmother	

Improvement imperatives

Improvement Imperative	Imperative
Energy	☑
Water	☑
Health/Clinic	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	30.00%
Food	50.00%
Education	5.00%
Transport	0.00%
Services	0.00%
Other	15.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	2	16 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONA5	3/27/03	Erin Dupak

TimeStart	Time End	Respondent Name	House Position
9:57 AM	10:13 AM	Festis Redata	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
3	0	0	0

Household Income Activity

Member	Activity/SourceType	Amount/Week
Son	Civil Servant	600
Son	Civil Servant	600
Son	Civil Servant	600

Education Levels

Level	Number
None	3

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☑	☐	☐
Village/Town Store	☐	☐	☐	☐

Decision makers

Decision Maker	Decision Process
all three of them	

Improvement imperatives

Improvement Imperative	Imperative
Energy	☑
House	☑
Health/Clinic	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	50.00%
Food	50.00%
Education	0.00%
Transport	0.00%
Services	0.00%
Other	0.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
2	3	13 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONA8	3/27/03	Justin Osgood

TimeStart	Time End	Respondent Name	House Position
10:40 AM	10:55 AM	Jan Booi	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
1	1	2	2

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Labourer	600

Education Levels

Level	Number
None	4
Other	2

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	1	8 M2

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	3	80 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONB2	3/26/03	Yvonne Mok

TimeStart	Time End	Respondent Name	House Position
2:14 PM	2:38 PM	Sofie (the translator)	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
1	1	1	4

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Labourer	2000

Education Levels

Level	Number
None	4
Other	3

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Paraffin lamp - regular	General lighting	2	3	365
Gas low pressure stove - double	Warm washing water	1	2	365
Gas low pressure stove - double	Rapid heating or frying	3	1	30
Gas low pressure stove - double	Boiling water any purpose	1	1.5	365
Gas low pressure stove - double	Medium heat	2	1.5	365
Wood fire (open)	Ironing	1	0.5	52
Paraffin wick stove - low cost single	Rapid heating or frying	1	8	90
Low Power radio	Radio	1	6	365
Dry cell battery radio	Radio	1	3	365

Present service use

Plate cooking	5
Lighting	2
Space heating	1
Hot water	6
Ironing	2
Refrigeration	200
Media & Other Services	1
Baking	25

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Dry Cell Battery	Vah/month	33.3	15	2
Low Power Elec	Vah/month	30	0	15
LPG	kg/month	9	100	1
Wood	kg/month	4.42	5	4

Fuel source purchase information

Source	Fuel
Local Store	Candles
Local Store	Paraffin
Local Store	Wood
Village/Town Sto	Dry Cell Battery
Village/Town Sto	LPG

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☑	☐	☐
Village/Town Store	☐	☐	☑	☐

Decision makers

Decision Maker	Decision Process
shared	

Improvement imperatives

Improvement Imperative	Imperative
Education	☑
Energy	☑
Water	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	15.00%
Food	35.00%
Education	1.00%
Transport	7.00%
Services	4.00%
Other	38.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	3	32 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONB3	3/26/03	Yvonne Mok

TimeStart	Time End	Respondent Name	House Position
2:41 PM	3:04 PM	Louisa	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
1	1	1	1

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Labourer	1000
Mother	Maid	680

Education Levels

Level	Number
None	2
Other	2

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Candle Holder	General lighting	3	4	100
Paraffin lamp - regular	General lighting	3	4	265
Paraffin stove - wick double plate	Boiling water any purpose	1	4	365
Paraffin stove - wick double plate	Medium heat	2	3.5	365
Paraffin stove - wick double plate	Ironing	1	1	52
Paraffin stove - wick double plate	Warm washing water	1	5	365
Dry cell battery radio	Radio	1	4	365

Present service use

Plate cooking	2
Lighting	6
Hot water	9
Ironing	1
Media & Other Services	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Dry Cell Battery	Vah/month	33.3	15	5
Candles	kg/month	0.432	5.95	1
Paraffin	l/month	1	5	15
Wood	kg/month	17.68	5	4

Fuel source purchase information

Source	Fuel
Local Store	Candles
Local Store	Paraffin
Local Store	Wood
Village/Town Sto	Dry Cell Battery

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☑	☐	☐
Village/Town Store	☑	☐	☐	☐

Decision makers

Decision Maker	Decision Process
shared	

Improvement imperatives

Improvement Imperative	Imperative
Energy	☑
Telephone	☑
Water	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	15.00%
Food	60.00%
Education	4.00%
Transport	20.00%
Services	1.00%
Other	0.00%

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Candle Holder	General lighting	1	2.5	365
Wood fire (open)	Ironing	1	1	104
Wood fire (open)	Medium heat	2	2	365
Wood fire (open)	Warm washing water	1	5	365
Wood fire (open)	Boiling water any purpose	1	2	365
Dry cell battery radio	Radio	1	4	365

Present service use

Plate cooking	2
Lighting	1
Space heating	1
Hot water	7
Ironing	1
Media & Other Services	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Dry Cell Battery	Vah/month	33.3	15	1
Candles	kg/month	0.432	5	1
Wood	kg/month	4.42	5	15

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONB5	3/26/03	Yvonne Mok

TimeStart	Time End	Respondent Name	House Position
3:37 PM	3:57 PM	Frida Bues	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
3	3	3	3

Household Income Activity

Member	Activity/SourceType	Amount/Week
Mother	Self employed, selling good	1000
Grandmother	Pensioner	250
Grandfather	Pensioner	250

Education Levels

Level	Number
None	3
Other	9

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Paraffin lamp - regular	General lighting	1	3	365
Wood fire (open)	Ironing	1	1	156
Wood fire (open)	Medium heat	1	3	365
Paraffin stove - wick double plate	Boiling water any purpose	1	6	365
Paraffin stove - wick double plate	Medium heat	2	4	365
Paraffin stove - wick double plate	Warm washing water	1	7	365
Dry cell battery radio	Radio	1	5	365

Present service use

Plate cooking	4
Lighting	1
Hot water	14
Ironing	1
Refrigeration	150
Media & Other Services	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Dry Cell Battery	Vah/month	33.3	15	5
Paraffin	l/month	2	10	30
Wood	kg/month	13.92	15	4

Fuel source purchase information

Source	Fuel
Local Store	Paraffin
Local Store	Wood
Village/Town Sto	Dry Cell Battery

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☑	☐	☐
Village/Town Store	☐	☐	☑	☐

Decision makers

Decision Maker	Decision Process
Head female (mo	

Improvement imperatives

Improvement Imperative	Imperative
Energy	☑
Water	☑
House	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	25.00%
Food	50.00%
Education	3.00%
Transport	0.00%
Services	1.00%
Other	21.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	3	36 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONB6	3/27/03	Yvonne Mok

TimeStart	Time End	Respondent Name	House Position
9:56 AM	10:13 AM	Bensin	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
2	1	4	2

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Small business owner	3000

Education Levels

Level	Number
None	2
Other	7

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Low power electric light 12 W CFL	General lighting	1	3	365
Gas low pressure stove - double	Rapid heating or frying	3	0.5	150
Gas low pressure stove - double	Boiling water any purpose	1	3	365
Gas low pressure stove - double	Medium heat	2	1	365
Wood fire (open)	Ironing	1	0.5	105
Wood fire (open)	Medium heat	1	1	365
Wood fire (open)	Warm washing water	1	15	120
Paraffin wick stove - low cost single	Rapid heating or frying	1	6	90
Low Power radio	Radio	1	4	365
Low-power electric television	Television	1	2	365

Present service use

Plate cooking	5
Lighting	1
Space heating	1
Hot water	30
Ironing	1
Media & Other Services	1
Baking	25

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Low Power Elec	Vah/month	30	0	30
LPG	kg/month	9	100	1
Paraffin	l/month	4	4.5	15
Wood	kg/month	4.42	0	30

Fuel source purchase information

Source	Fuel
Village/Town Sto	LPG
Village/Town Sto	Paraffin

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☐	☐	☐
Village/Town Store	✓	☐	✓	☐

Decision makers

Decision Maker	Decision Process
father	

Improvement imperatives

Improvement Imperative	Imperative
Energy	✓
Water	✓
House	✓

Expenditure pattern

Expenditure Type	Expenditure
Energy	1.00%
Food	40.00%
Education	3.00%
Transport	15.00%
Services	1.00%
Other	40.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	3	30 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONB7	3/26/03	Yvonne Mok

TimeStart	Time End	Respondent Name	House Position
10:18 AM	10:31 AM	Franz Rooi	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
1	1	1	1

Household Income Activity

Member	Activity/SourceType	Amount/Week
Father	Labourer	1500

Education Levels

Level	Number
None	1
Other	3

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Candle Holder	General lighting	1	4	365
Dry cell battery radio	Radio	1	4	365
Paraffin wick stove - low cost single	Warm washing water	1	2	365
Paraffin wick stove - low cost single	Medium heat	1	4.5	365
Paraffin wick stove - low cost single	Ironing	1	1	52
Paraffin wick stove - low cost single	Boiling water any purpose	1	2	365

Present service use

Plate cooking	1
Lighting	1
Hot water	4
Ironing	1
Media & Other Services	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Dry Cell Battery	Vah/month	33.3	16	3
Candles	kg/month	0.432	6	1
Paraffin	l/month	2	4.5	4

Fuel source purchase information

Source	Fuel
Village/Town Sto	Candles
Village/Town Sto	Dry Cell Battery
Village/Town Sto	Paraffin

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☐	☐	☐
Village/Town Store	☐	☑	☐	☐

Decision makers

Decision Maker	Decision Process
share	

Improvement imperatives

Improvement Imperative	Imperative
Education	☑
TV & Radio	☑
Water	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	15.00%
Food	35.00%
Education	5.00%
Transport	40.00%
Services	5.00%
Other	0.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	2	16 **M2**

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONB8	3/27/03	Yvonne Mok

TimeStart	Time End	Respondent Name	House Position
10:36 AM	10:48 AM	Olfrida Gertze	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
3	3	1	2

Household Income Activity

Member	Activity/SourceType	Amount/Week
Mother	Maid	500

Education Levels

Level	Number
None	2
Other	7

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Candle Holder	General lighting	1	5	100
Paraffin lamp - regular	General lighting	1	5	265
Wood fire (open)	Ironing	1	1	52
Wood fire (open)	Medium heat	2	4.5	365
Wood fire (open)	Warm washing water	5	5	365
Wood fire (open)	Boiling water any purpose	2	2	365
Dry cell battery radio	Radio	1	5	365

Present service use

Plate cooking	2
Lighting	2
Hot water	7
Ironing	1
Media & Other Services	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Dry Cell Battery	Vah/month	199.8	30	2
Candles	kg/month	0.432	4.45	1
Paraffin	l/month	1	4.5	2
Wood	kg/month	17.68	5	5

Fuel source purchase information

Source	Fuel
Local Store	Candles
Local Store	Paraffin
Local Store	Wood
Village/Town Sto	Dry Cell Battery

Fuel purchase preferences

Source	Price	Close and Energy	No Choice	Support the Source
Other Village	☐	☐	☐	☐
Local Store	☐	☑	☐	☐
Village/Town Store	☐	☐	☑	☐

Decision makers

Decision Maker	Decision Process
Mother	

Improvement imperatives

Improvement Imperative	Imperative
Energy	☑
Water	☑
House	☑

Expenditure pattern

Expenditure Type	Expenditure
Energy	20.00%
Food	54.00%
Education	2.00%
Transport	20.00%
Services	4.00%
Other	0.00%

House layout

Number of Structures	Number of Rooms	Total Housed Area
1	2	24 M2

Individual Questionnaire

Sample Data

VillageName	Reference Number	Date	Researcher
Ongulumbashe	ONB9	3/27/03	Yvonne Mok

TimeStart	Time End	Respondent Name	House Position
10:44 AM	10:59 AM	Libertine Namubes	

Household Composition

Adult Males	Adult Females	School Children	Non School Children
1	1	0	5

Household Income Activity

Member	Activity/SourceType	Amount/Week
Mother	Unemployed	0

Education Levels

Level	Number
None	6
Other	1

Appliance and Energy Service Information

Appliance	Service	Quantity	Use (hrs)	Use(days per annum)
Candle Holder	General lighting	1	3	365
Wood fire (open)	Ironing	1	1	52
Wood fire (open)	Medium heat	2	2.5	100
Wood fire (open)	Boiling water any purpose	1	2	180

Present service use

Plate cooking	2
Lighting	1
Hot water	2
Ironing	1

Fuel purchase information

Fuel	Units	Purchase Quantity	Unit Cost	Purchases Per Month
Candles	kg/month	0.072	1.3	3
Wood	kg/month	4.42	5	5

Fuel source purchase information

Source	Fuel
Local Store	Candles
Local Store	Wood

Appendix G.5.2: General Reports

Demographic Averages

This Report lists the averages of Demographics,Income,Education,Expenditure and Improvement Imperatives out of the total sample of questionnaires in the database.

Family average

Adult Males	Adult Females	School Children	Non-School Children
1.5	1.416667	1.25	1.61111111

Income averages

Member	Activity	Amount
Father	Small business owner	1466.666667
Father	Self employed, selling goods	937.5
Father	Works in Taxi Industry	3000
Father	Construction Workers	1000
Father	Civil Servant	850
Father	Migrant Workers	600
Father	Labourer	1027.777778
Mother	Unemployed	0
Mother	Maid	360
Mother	Pensioner	350
Mother	*Teacher*	740
Mother	Self employed, selling goods	1000
Mother	Labourer	1000
Son	Construction Workers	800
Son	Civil Servant	600

Average House layout

Avg No Structures	Avg No Rooms	Avg Total Housed Area
1.1	2.4	29.3

Total fuel averages

This report displays all of the calculated fuel data in the database not divided into any band

Fuel	Average Monthly Fuel Use	Units	Average Cost
Candles	0.83	kg/month	3
Dry Cell Battery	44.40	Vah/month	7
Low Power Elec	102.50	Vah/month	1
LPG	4.11	kg/month	35
Paraffin	9.97	l/month	6
Wood	77.42	kg/month	5

Total Average expenditure of all fuels in sample 56.4

Appendix G.5.3: Reports based on income

Fuel Averages   Low   Income group

Fuel	Average Monthly Fuel Use	Units	Average Cost
Candles	1.00	kg/month	2.62
Dry Cell Battery	47.78	Vah/month	7.63
Low Power Elec	35.22	Vah/month	0.87
LPG	3.74	kg/month	22.91
Paraffin	6.13	l/month	5.12
Wood	93.02	kg/month	6.74

Average fuel cost over the income level you have selected 6.73913043478

Appliance Averages Low Income Level

Appliance	Service	Households	Quantity	Usage/ year	Penetration	Avg Hrs in sample per / year
Gas low pressure stove - double	Rapid heating or frying	36	1	168.0	4.3%	7.3
Paraffin wick stove - low cost single	Rapid heating or frying	36	1	337.5	4.3%	14.7
Gas low pressure stove - single	Medium heat	36	1	1095.0	4.3%	47.6
Gas low pressure stove - double	Medium heat	36	6	11497.5	26.1%	499.9
Wood fire (open)	Medium heat	36	12	15230.0	52.2%	662.2
Paraffin wick stove - low cost single	Medium heat	36	2	1460.0	8.7%	63.5
Paraffin stove - wick double plate	Medium heat	36	4	7222.5	17.4%	314.0
Wood stove - pressed steel	Medium heat	36	1	6570.0	4.3%	285.7
Wood fire (open)	Simmering	36	1	2920.0	4.3%	127.0
Candle Holder	General lighting	36	18	22485.5	78.3%	977.6
Paraffin lamp - regular	General lighting	36	13	17528.5	56.5%	762.1
Gas low pressure stove - double	Warm washing water	36	2	455.0	8.7%	19.8
Wood fire (open)	Warm washing water	36	6	13889.5	26.1%	603.9
Paraffin wick stove - low cost single	Warm washing water	36	1	5475.0	4.3%	238.0
Paraffin stove - wick double plate	Warm washing water	36	4	7405.0	17.4%	322.0
Wood stove - pressed steel	Warm washing water	36	1	208.0	4.3%	9.0
Gas low pressure stove - single	Boiling water any purpose	36	1	7300.0	4.3%	317.4
Gas low pressure stove - double	Boiling water any purpose	36	5	5840.0	21.7%	253.9
Wood fire (open)	Boiling water any purpose	36	11	8090.0	47.8%	351.7
Paraffin wick stove - low cost single	Boiling water any purpose	36	1	365.0	4.3%	15.9

Demographic Averages Low Income level

This Report lists the averages of Demographics,Income,Education,Expenditure and Improvement Imperatives out of the total number of questionnaires in the income level you have chosen.

Family average

Adult Males	Adult Females	School Children	Non-School Children
1.4	1.6	1.2	1.6

Income averages

Member	Activity	Amount
Father	Small business owner	60.9
Father	Self employed, selling goods	20.7
Father	Construction Workers	43.5
Father	Civil Servant	21.7
Father	Migrant Workers	26.1
Father	Labourer	106.5
Mother	Unemployed	0.0
Mother	Maid	95.7
Mother	Pensioner	15.2
Mother	Teacher	32.2
Mother	Labourer	43.5
Daughter	Unemployed	0.0
Daughter	Maid	40.2
Daughter	Labourer	4.3
Brother	Unemployed	0.0
Brother	Small business owner	39.1
Grandmother	Pensioner	21.7
Grandfather	Pensioner	10.9

Appendix G.6:
EnPower Algorithm Reports:
Okuryangava, Namibia

Appendix G.6.1: "Low Income Demog" & "Low Income Scenario": Comparing baskets

Basket contents and access cost

Analysis	Okuryangava Study (OK and ON)	Demographic	Low Income Demog
Scenario	Low income scenario		

Basket Low #1

No.	Appliance	Unit cost		Total cost		
1 off Available ☑	Wood Evat stove Used in Namibia, energy efficient stove	150.00	ea	150.00	total	ZAR
1 off Available ☑	Dry cell battery radio	90.00	ea	90.00	total	ZAR
3 off Available ☑	Solar lantern	2,300.00	ea	6,900.00	total	ZAR

Total cost of Appliances **7,140.00** **ZAR**

Fuel	Fuel access cost	
Dry Cell Battery	0.00	ZAR
Sun	0.00	ZAR
Wood	0.00	ZAR

Total Fuel access cost **0.00** **ZAR**

Total Basket access cost **7,140.00** **ZAR**

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Basket Low #2

No.	Appliance	Unit cost	Total cost	
1 off Available ☑	Low Power radio Plugs into the Pv type 12Volt system	90.00 ea	90.00 total	ZAR
3 off Available ☑	Low power electric light 12 W CFL High efficiency bulb	273.00 ea	819.00 total	ZAR
1 off Available ☑	Gas low pressure stove - single	40.00 ea	40.00 total	ZAR
1 off Available ☑	Solar stove Uses parabolic mirrors to provide concentrated 200 to 400 degrees Celsius heat	600.00 ea	600.00 total	ZAR

Total cost of Appliances **1,549.00** **ZAR**

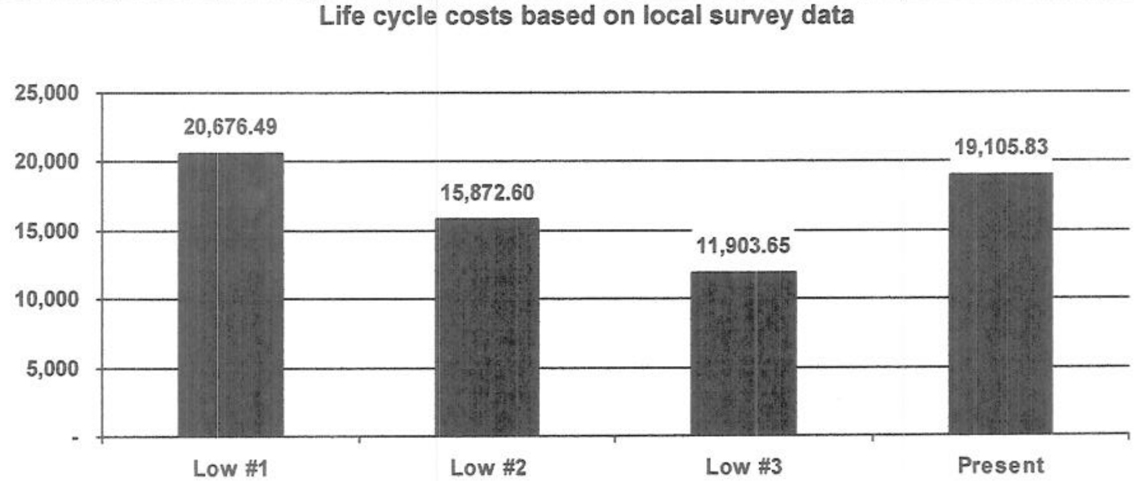
Fuel	Fuel access cost	
Solar PV 150	6,000.00	ZAR
LPG	299.71	ZAR
Sun	0.00	ZAR

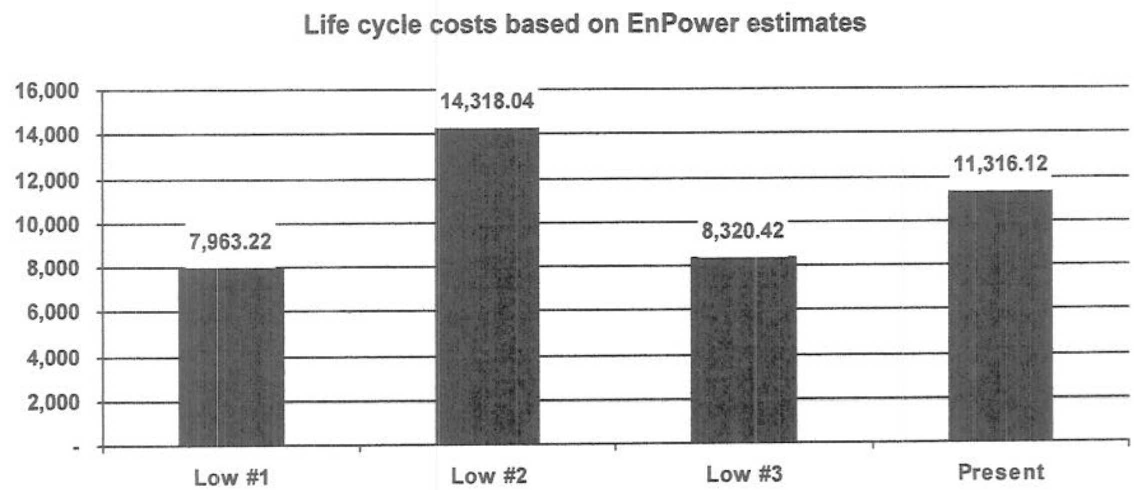
Total Fuel access cost **6,299.71** **ZAR**

Total Basket access cost **7,848.71** **ZAR**

Life-cycle costs

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		





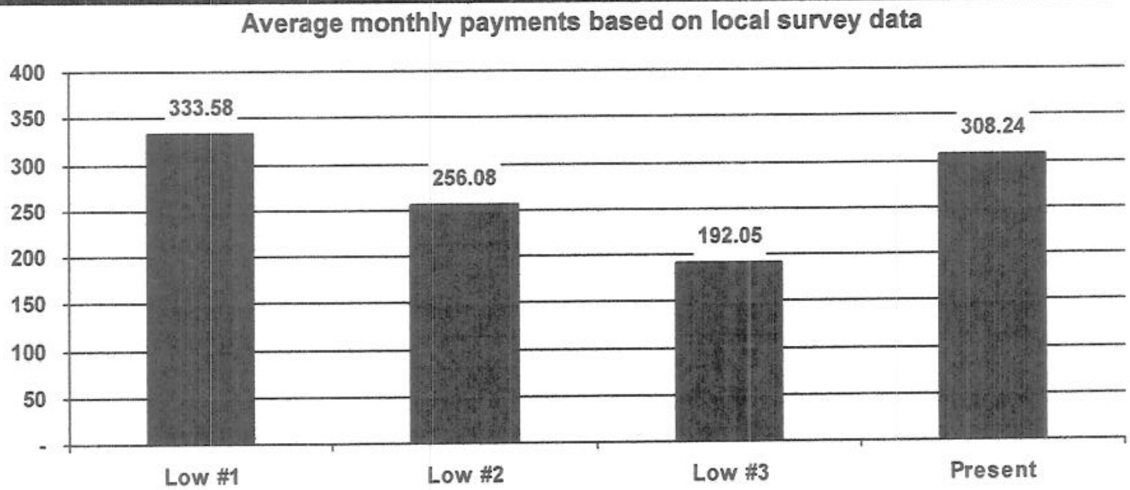
Comparison period 10.0 **years** **Annual discount rate** 15% **All costs in** ZAR

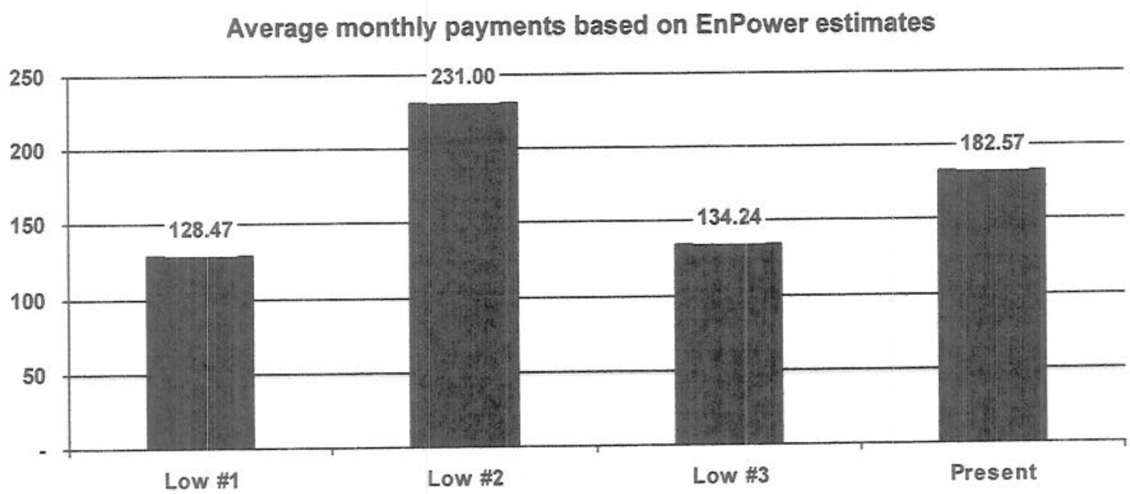
NOTES

Life cycle costs are used to show how much something costs over a defined period. For example an Appliance that is cheap to buy but expensive to run may cost more in the long-term than a more expensive device that is cheaper to run. Life cycle costs are based on a comparison period and a discount rate. See the EnPower guidance for more explanation. Lower life cycle costs mean lower expenditure over the long-term.

Average monthly expenditure

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

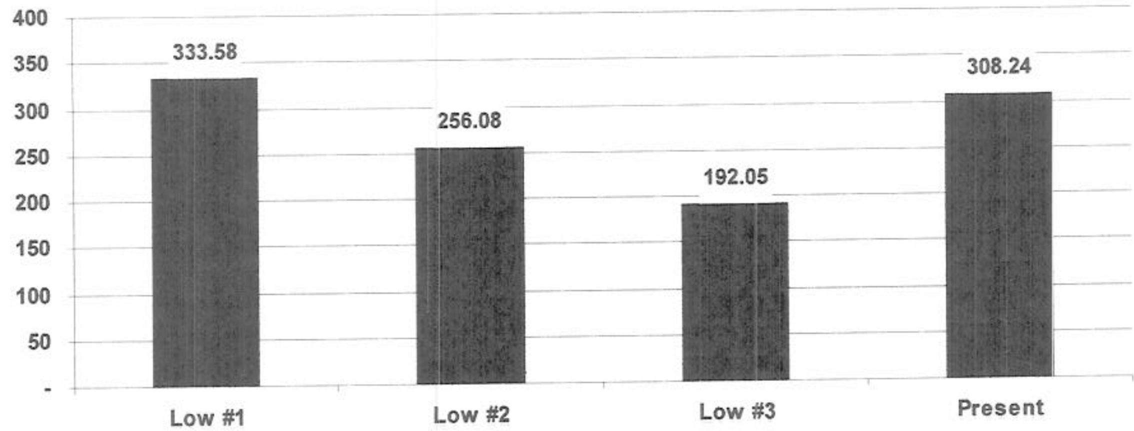




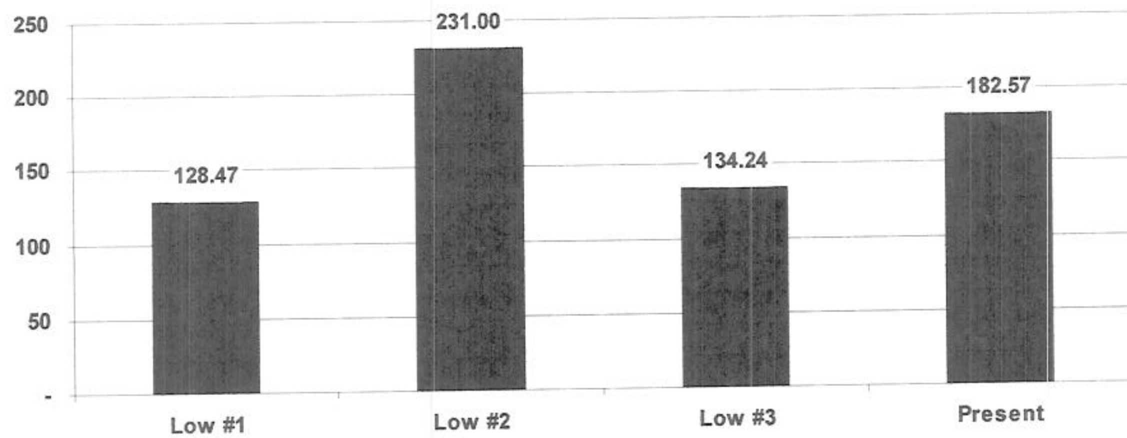
Comparison period 10.0 **years** **Annual discount rate** 15% **All costs in** ZAR

Analysis	Okuryangava Study (OK and ON)
Scenario	Low income scenario
Demographic	Low Income Demog

Average monthly payments based on local survey data



Average monthly payments based on EnPower estimates

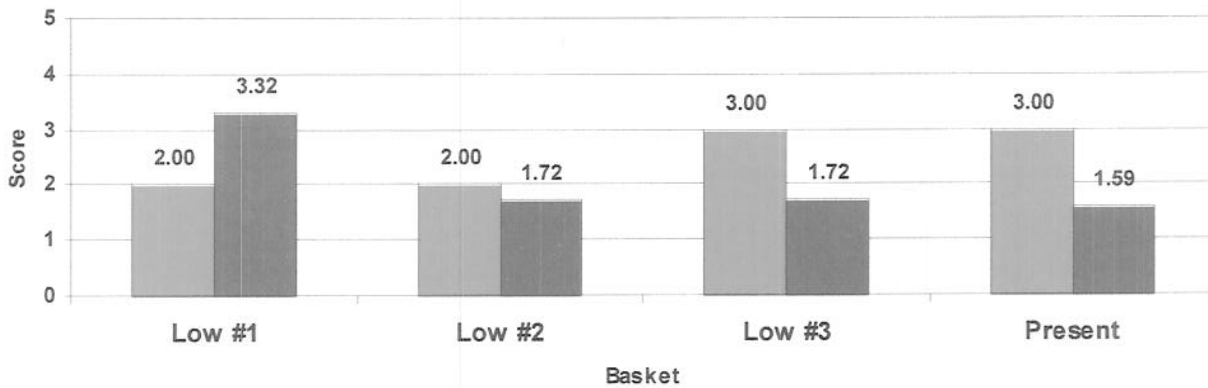


Comparison period 10.0 **years** **Annual discount rate** 15% **All costs in** ZAR

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Quantity Score
Rating score

Plate cooking Cooking with pots and pans, not grilling or baking



This Report compares different Baskets in terms of their Performance. All of the Baskets shown here provide at least the minimum level of Service. If the Basket meets the mimimum requirement for a Service it gets a Score of 1. If the Basket meets the Maximum requirement the Basket it Scores 5. If the Basket lies somewhere between the minimum and maximum requirement then it Scores somewhere between 1 and 5. The Score depends on the Performance of each Appliance in the Basket that can provide that Service. If the Basket exceeds the maximum requirement it still only Scores a maximum of 5 points.

If a Basket is shown on this form then it is suitable for the Household and will meet their needs. The basket with the highest overall Score is the best Basket in terms of its Performance. The Performance of the Basket must be balanced against its cost, the Householders' Preferences, Environmental Performance etc. See the EnPower Guidance for more information.

Present estimated fuel expenditure

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Present Fuel use and cost breakdown

Fuel type	Fuel	Fuel Use [/month] Survey	Calc.	Units	Unit cost		Fuel Cost [/month] Survey	Calc.	
Candles		1.00	0.98	kg	13.89	ZAR/kg	13.91	13.58	ZAR
Dry Cell Battery		47.78	46.48	Vah	0.45	ZAR/Vah	21.50	20.91	ZAR
Low Power Elec	3rd Party charging	35.22	33.21	Vah	0.33	ZAR/Vah	11.62	10.96	ZAR
Low Power Elec	Solar PV 100	35.22	33.21	Vah	0.01	ZAR/Vah	0.18	0.17	ZAR
Low Power Elec	Solar PV 150	35.22	33.21	Vah	0.01	ZAR/Vah	0.18	0.17	ZAR
Low Power Elec	Solar PV 300	35.22	33.21	Vah	0.01	ZAR/Vah	0.18	0.17	ZAR
LPG		3.74	3.99	kg	10.00	ZAR/kg	37.39	39.89	ZAR
Paraffin		6.13	6.54	l	5.00	ZAR/l	30.65	32.69	ZAR
Wood		93.02	97.38	kg	1.13	ZAR/kg	105.12	110.04	ZAR

Survey means values estimated by Householders based on their present monthly Fuel purchases.
Calc. means values estimated based on the Appliances and Services presently used by the Housholders.

Present Fuel cost estimate (takes information from the table above)

Fuel type	Surveyed [/month]	Calculated [/month]	
Candles	13.91	13.58	ZAR
Dry Cell Battery	21.50	20.91	ZAR
Low Power Elec	0.18 - 11.62	0.17 - 10.96	ZAR
LPG	37.39	39.89	ZAR
Paraffin	30.65	32.69	ZAR
Wood	105.12	110.04	ZAR
Monthly fuel expenditure estimates	208.75 - 220.20	217.28 - 228.07	ZAR

Survey means values estimated by Householders based on their present monthly Fuel purchases.
Calc. means values estimated based on the Appliances and Services used presently by the Housholders.

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

[redacted]

Present Fuel use and cost breakdown

Present Fuel cost estimate (takes information from the table above)

[redacted]

Present Fuel use and cost breakdown

Present Fuel cost estimate (takes information from the table above)

This report lists the Fuels that are currently used by the Community. This information comes from two different places. The Householders were asked how much Fuel they used each month. This is the 'Surveyed' amount. The householders were also asked what Appliances they used to supply which Services and how much they used them. From this the 'Calculated' Fuel use can be estimated by EnPower.

The top table shows the Fuels that are used, how much they are used and how much they cost. For some Fuel Types we cannot be sure which specific Fuel is used. For example, if the Household uses Low Power electricity then we cannot be sure whether they use Dry Cell Batteries or Lead Acid Batteries for example. All the different options are shown in the top table.

The bottom table takes information from the top table. This table shows the range of Fuel Expenditure by each average Household on each type of Fuel.

Importance of preference dimensions

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Hot water

	Dimension	Importance
1	Better Service	38%
2	Capacity	38%
3	Convenient	13%
4	Safety and health	13%

Ironing

	Dimension	Importance
1	Convenience	40%
2	Cleanliness	30%
3	Safety and health	20%
4	Appearance	10%

Lighting

	Dimension	Importance
1	Convenience	31%
2	Maintenance	23%
3	Appearance	15%
4	Better light	15%
5	Safety and health	15%

Media & Other Services

	Dimension	Importance
1	Better service	33%
2	Continuous	33%
3	Maintenace	33%

Plate cooking

	Dimension	Importance
1	Maintenance	22%
2	Reliability	22%
3	Safety and health	22%
4	Convenience	17%
5	Better cooking	13%
6	Appearance	4%

This report lists the Dimensions the Services required by the Community. It shows the relative importance of the Dimensions based on the information provided by the Community. In each case the most important Dimensions are at the top of the list. This report does not however make any judgements on the relative importance of the different Services.

Basket environmental impact

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Basket Low #1

Fuel		**Annual household emmissions [kg/year]**		
		CO2	**SO2**	**NOx**
Dry Cell Battery		0 - 0	0 - 0	0 - 0
Solar-thermal	Sun	0 - 0	0 - 0	0 - 0
Wood		0 - 0	0 - 0	0 - 0
	Total	**0 - 0**	**0 - 0**	**0 - 0**

Basket Low #2

Fuel		**Annual household emmissions [kg/year]**		
		CO2	**SO2**	**NOx**
Low Power Elec	Solar PV 150	0 - 0	0 - 0	0 - 0
LPG		0 - 0	0 - 0	0 - 0
Solar-thermal	Sun	0 - 0	0 - 0	0 - 0
	Total	**0 - 0**	**0 - 0**	**0 - 0**

Basket Low #3

Fuel		**Annual household emmissions [kg/year]**		
		CO2	**SO2**	**NOx**
High power electricity	PE 2.5 amp	0 - 0	0 - 0	0 - 0
LPG		0 - 0	0 - 0	0 - 0
Solar-thermal	Sun	0 - 0	0 - 0	0 - 0
	Total	**0 - 0**	**0 - 0**	**0 - 0**

Basket Present

Fuel		**Annual household emmissions [kg/year]**		
		CO2	**SO2**	**NOx**
Candles		0 - 0	0 - 0	0 - 0
Dry Cell Battery		0 - 0	0 - 0	0 - 0
Paraffin		0 - 0	0 - 0	0 - 0
Wood		0 - 0	0 - 0	0 - 0
	Total	**0 - 0**	**0 - 0**	**0 - 0**

This report estimates the amount of emissions of carbon dioxide (CO_2), sulphur dioxide (SO_2) and nitrogen oxides (NOx) that would be resleased into the atmosphere by the users of these baskets. This gives an idea as to which basket has the highest environmental impact. High numbers mean a higher level of impact. This information may be interesting to Stakeholders who are concerned about the environment.

Scenario details (Part 1)

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Analysis name	Okuryangava Study		
Community	OK and ON		
Location	Okuryangava		
Region	Khomas Region		
Country	South Africa	**Currency**	South African Rand (ZAR)
Community description	Okahandja Park (OK) and Ongulumbashe (ON) are situated within Okuryangava, 15 minutes north of Windhoek. Okuryangava consists of 300-400 households. The occupants are peri-urban poor, where mostly the women work as domestic workers.		
Analysis comment	The Okuryangava village was selected and engaged through the EnPower process and analysed according to the EnPower research framework and algorthim. We three WPI students will be evaluating the process according to our developed criteria.		
Demographic name	Low Income Demog		
Demograhpic description	Separate analysis for the lowest economic segment of the community. Represented by those houdeholds earning less than R1100 per month.		
No. households	23		
Scenario name	Low income scenario		
Scenario description	Development of a range of potential baskets for the low income segment within Okuryangava. Those earning less than R1100 per month.		
Comparison period	10 years		
Discount rate	15.00%		
Comment	Okuryangava: 15% is the suggested value from the manual		
DataSource	Imported from Data Collation Tool		

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Present Basket

Appliance

Candle Holder	Standard candle holder
Dry cell battery radio	
Gas low pressure stove - double	
Gas low pressure stove - single	
Low Power radio	Plugs into the Pv type 12Volt system
Low-power electric television	For use with a low-power electricity supply, not batteries
Paraffin lamp - regular	
Paraffin stove - wick double plate	
Paraffin wick stove - low cost single	
Wood fire (open)	Typical fire used for cooking
Wood stove - pressed steel	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Present Fuel Use Check

Fuel	Surveyed	Calculated	Units	Difference
Candles	1.002	0.978	kg/day	-2%
Dry Cell Battery	47.778	46.476	Vah/day	-3%
Low Power Elec	35.217	33.210	Vah/day	-6%
LPG	3.739	3.989	kg/day	6%
Paraffin	6.130	6.538	l/day	6%
Wood	93.023	97.378	kg/day	4%

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Present Service Quantities

Service	Quantity	
Baking	4.16667	litres
Hot water	7.63044	litres
Ironing	1	irons
Lighting	2.30435	light sources
Media & Other Services	1	N/A
Plate cooking	2.39130	hot plates
Refrigeration	100	litres
Space heating	1	sources

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Fuel Local (only Fuels Available Locally)

Now = Cost Now   Pos = Possible / Future Cost

Fuel	Unit Cost (ZAR)			Access Capital Cost (ZAR)	
Dry Cell Battery	0.45	/Vah	Okuryangava: $15 for 33.3 Vah	0.00	$15 for 33.3 Vah
Candles	13.89	/kg	$1 for .072	0.00	Default value
Solar PV 150	0.01	/Vah	this is really Solar PV 50	6,000.00	Okuryangava cost for Solar PV 50
Solar PV 300	0.01	/Vah	Default value	29,700.00	Okuryangava
Solar PV 100	0.01	/Vah	Local cost to replace battery etc. per Vah	10,700.00	Okuryangava, Namiiban cost shown as the local costs
LPG	10.00	/kg	Okuryangava: $90/9kg	299.71	Default value
Paraffin	5.00	/l	Default value	0.00	Default value
Sun	0.00	/Sun	Default value	0.00	Default value
Wood	1.13	/kg	Okuryangava: $5/4.42kg	0.00	Default value
PE 20 amp	0.60	/kWh	copied from okamapuku	7,130.00	
PE 2.5 amp	0.70	/kWh	value copied from okamapuku	500.00	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Local Appliance Costs (only Appliances Available Locally)

Available Appliance	Local Cost (ZAR)
Solar lantern	2,300.00
Candle Holder	1.00
Low power electric light 12 W CFL	273.00
High power electric light 20 W CFL	100.00
High power electric light 60W incandescent	54.00
Paraffin lamp - regular	20.50
Wood Evat stove	150.00
High power electric double plate cooker	200.00
Gas low pressure stove - single	40.00
Gas low pressure stove - double	240.00
Wood fire (open)	0.00
Paraffin stove - wick double plate	59.00
Solar stove	600.00
Solar box cooker	700.00
High power electric freezer (70l)	1,300.00
High power electric refrig. with freezer (190l)	1,650.00
Gas refrigerator (100l)	4,227.00
High power electric Iron	170.00
Low Power radio	90.00
Low power electricity refrigerator	1,500.00
Low-power electric television	314.00
Wind up/solar radio on on manual winding	330.00
Dry cell battery radio	90.00
High power electric television	1,379.00
High power electric radio	170.00

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Scenario details (Part 2)

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Service Requirements

Service type	Min	Max		Min	Max	
Hot water	1	1	litres	1	1	N/A
Ironing	1	3	irons	1	1	N/A
Lighting	1	10	light sources	45	1000	lumen @ 1m
Media & Other Services	1	1	N/A	1	1	N/A
Plate cooking	1	5	hot plates	0.25	5	total kW heat output
Refrigeration	50	300	litres	1	1	N/A

Analysis	Okuryangava Study (OK and ON)	Demographic	Low Income Demog
Scenario	Low income scenario		

Service Usage (Required Services only)

	Service	Quantity		Use	
Hot water	Boiling water any purpose	1	litres	3.5	litres/day
Hot water	Warm washing water	1	litres	4	litres/day
Ironing	Ironing	1	irons	1	hours/day
Lighting	General lighting	3	light sources	2.3	hours/day
Media & Other Services	Radio	1	N/A	3	hours/day
Plate cooking	Medium heat	2	hot plates	2.75	hours/day

Scenario summary

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Analysis name	Okuryangava Study
Community	OK and ON
Location	Okuryangava
Region	Khomas Region
Country	South Africa
Community description	Okahandja Park (OK) and Ongulumbashe (ON) are situated within Okuryangava, 15 minutes north of Windhoek. Okuryangava consists of 300-400 households. The occupants are peri-urban poor, where mostly the women work as domestic workers.
Analysis comment	The Okuryangava village was selected and engaged through the EnPower process and analysed according to the EnPower research framework and algorthim. We three WPI students will be evaluating the process according to our developed criteria.
Demographic name	Low Income Demog
No. households	23
Scenario name	Low income scenario
Demograhpic description	Separate analysis for the lowest economic segment of the community. Represented by those houdeholds earning less than R1100 per month.
Scenario description	Development of a range of potential baskets for the low income segment within Okuryangava. Those earning less than R1100 per month.
Discount rate	15.00%
Comment	Okuryangava: 15% is the suggested value from the manual
Comparison period	10

Present and future benefits comparison

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Present and future benefits comparison

Service type	Service	Present [/year]	Future [/year]	Change	Units
Baking	Baking food	44	0	(-100%)	hours/year
Hot water	Boiling water any purpose	1,134	1,278	(+13%)	litres/year
Hot water	Warm washing water	1,193	1,460	(+22%)	litres/year
Ironing	Ironing	47	52	(+10%)	hours/year
Lighting	Close lighting	0	2,190	-	hours/year
Lighting	General lighting	1,740	2,518	(+45%)	hours/year
Media & Other Services	Radio	793	1,095	(+38%)	hours/year
Media & Other Services	Television	14	0	(-100%)	hours/year
Plate cooking	Medium heat	1,873	2,008	(+7%)	hours/year
Plate cooking	Rapid heating or frying	22	0	(-100%)	hours/year
Plate cooking	Simmering	127	0	(-100%)	hours/year

This report shows a comparison of the Present Benefits received by the community compared to those they will receive in the Future. A Benefit is the delivery of some Service, such as the number of portions of food, or the total number of hours of lighting. The basis of comparison depends on the Service. The numbers above are the total number of Benefits received by a Household each year. Also shown is the change between the past and the future. This is shown as a percentage increase (e.g. +10%) or decrease (e.g. -10%).

Basket tests

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario		

Basket	Overall	Fuels available	Quantity test	Rating test	Can supply services
Low #1	**Passed**	☑	☑	☑	☑
Low #2	**Passed**	☑	☑	☑	☑
Low #3	**Passed**	☑	☑	☑	☑
Low #4	**Passed**	☑	☑	☑	☑
Med #2	**Passed**	☑	☑	☑	☑
Med #3	**Passed**	☑	☑	☑	☑
Med #4	**Passed**	☑	☑	☑	☑
Present	**Passed**	☑	☑	☑	☑
Low #5	**Passed**	☑	☑	☑	☑
Low #6	**Passed**	☑	☑	☑	☑
Med #1	**Passed**	☑	☑	☑	☑

This report lists all of the Baskets that have been defined and shows which ones have passed the Basket tests. If a Basket fails it is for one of the following reasons:

Test	Reason
Fuels available	One or more Appliance in the Basket uses a Fuel that is not available locally
Quantity test	The Basket cannot provide enough of each type of Service. For example the households may require a minimum number of lights. If the Basket contains too few lights it will fail this test.
Rating test	The minimum level of one or more Service cannot be met by the Appliances in this Basket. The Basket must provide a minimum level (or 'Rating') of Service. For example, if the Basket does provide lights but they are not bright enough for the Household then the Basket will fail this test.
Can supply services	The basket cannot provide one of the Services required by the Household. For example a Basket that contains no lights cannot provide lighting. If lighting were required by the Household then such a Basket would fail this test.

Appendix G.6.2: “Low Income Demog” & “Low Income Scenario”: Individual baskets

Important considerations about fuels

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #1

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
Solar-thermal			
Sun Exit/Switching cost		There is not cost to start using sun power. - Solar lantern	
Sun Pollution		Using solar power produces no pollution of any kind. - Solar lantern	
Sun Quality of Life		Solar power does not produce smoke or other unpleasant fumes. - Solar lantern	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #1

Importance **H** = High
M = Medium
L = Low

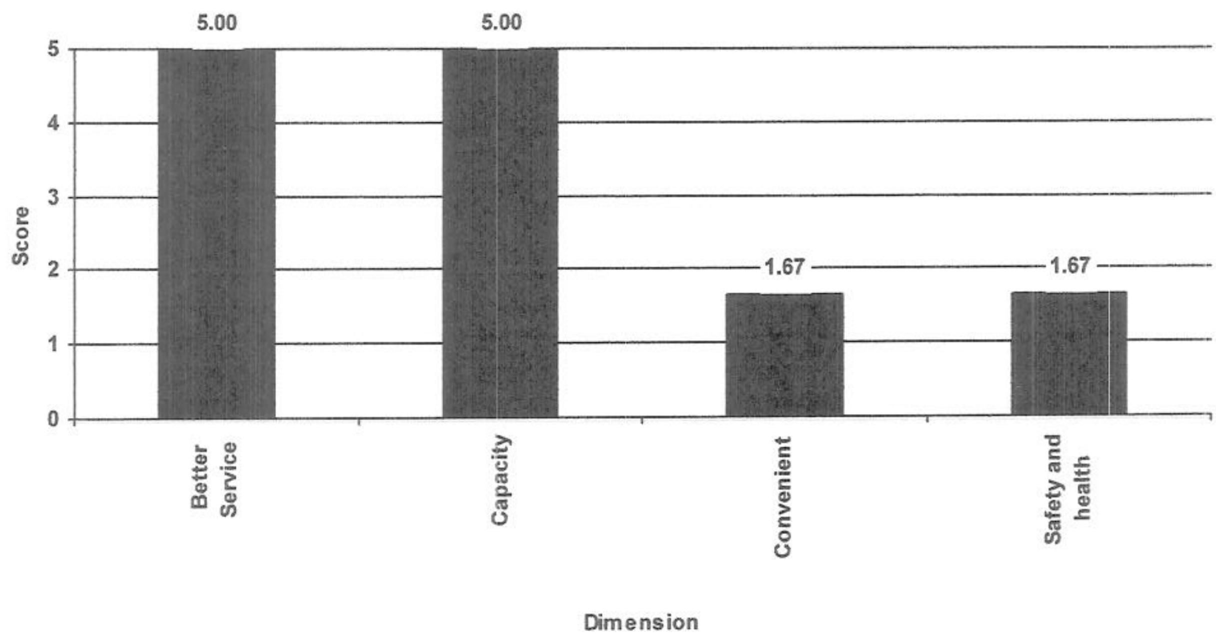
Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
Wood			
Burning	L	Burns are unlikely but may occur when using wood. - Wood Evat stove	
Deforestation	M	There is a moderate risk of deforestation occurring when using this type of fuel. - Wood Evat stove	Consider how much wood can be cut down each year without risking not having enough fuel for the next and future years.
Fire Risk	M	A moderate risk of fire occurring exists when this fuel is used. - Wood Evat stove	Always keep children away from the flames and avoid having flamable objects, such as curtains, near the fire. Never leave the fire unattended.
Smoke Inhalation	M	Smoke inhalation can be an issue with this fuel type and it must be given careful consideration. The smoke from wood can be particularly harmful. - Wood Evat stove	Ventilate the area well, fit a good chimney.
Time to Collect	L/M	Time must be spent collecting this fuel. - Wood Evat stove	

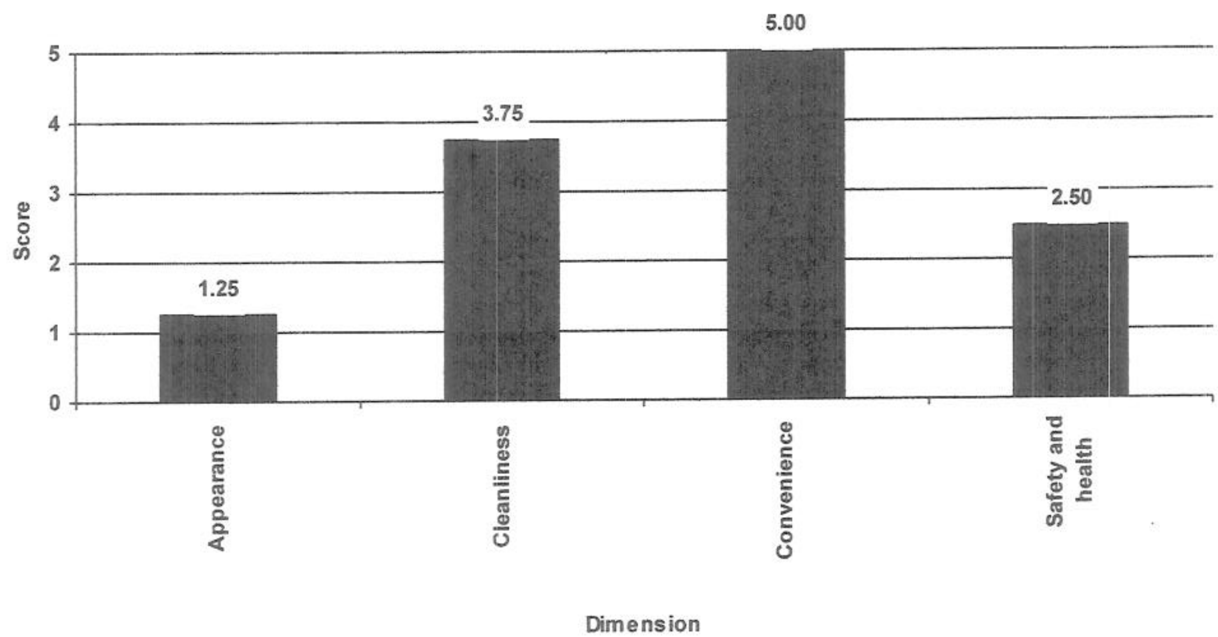
Preference scores

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #1

Hot water Heating water for any purpose, e.g. beverages, dishes, personal, clothes washing.

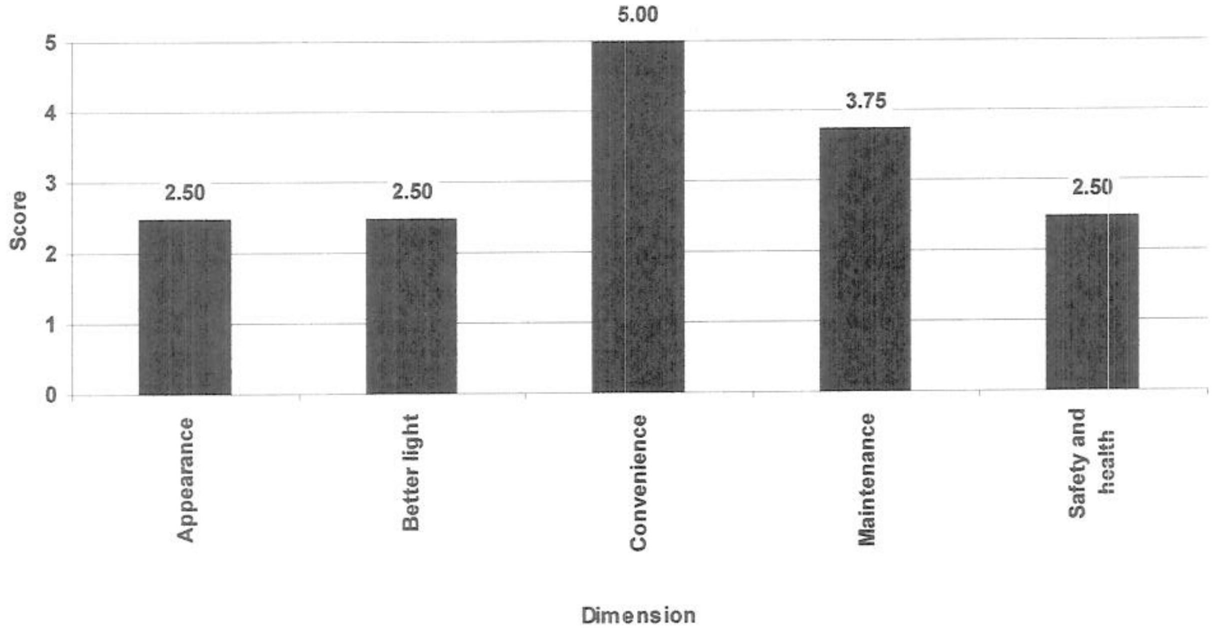


Ironing Heating an iron (any type of iron)



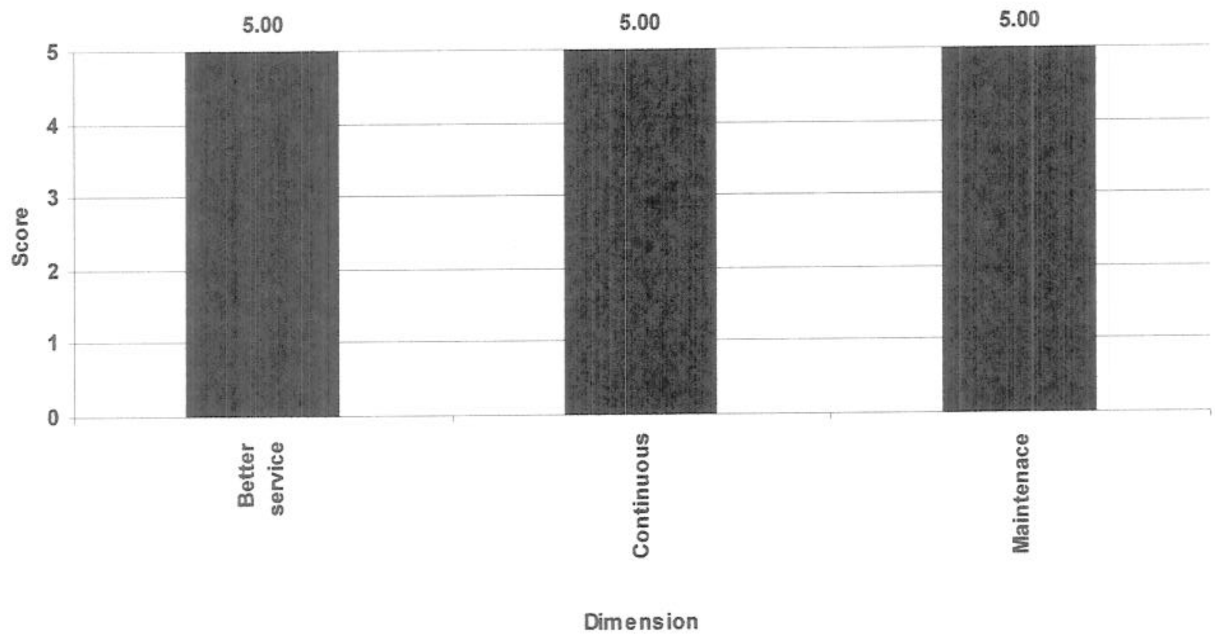
Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #1

Lighting



Media & Other Services

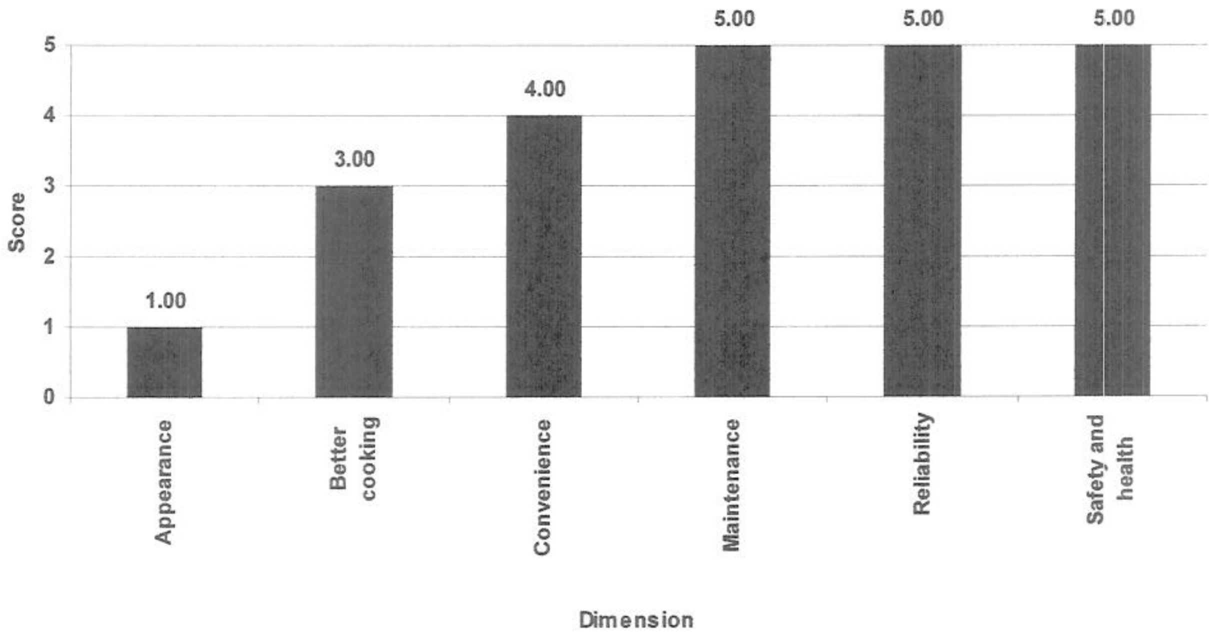
Supply of Electricity for any household appliance, not listed services, e.g. cooking.



Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #1

Plate cooking

Cooking with pots and pans, not grilling or baking



This report shows the average Scores against each Dimension of each Service for the Basket. The Scores take into account the Importance of each Dimension. If the Basket uses more than one Fuel to supply a particular Service then the Scores are the average Score. The Scores are adjusted so that the highest Score for any Dimension is always 5.

Important considerations about fuels

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #2

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
Low Power Elec			
3rd Party charging Poisoning	M	The lead in the batteries is toxic and there is a risk of poisoning. This is especially dangerous to children and pregnant women, can cause brain damage and metabolic disorders. - Low power electric light 12 W CFL - Low Power radio	Read the instructions and keep away from children.
3rd Party charging Pollution	M	If these batteries are not disposed of carefully they can cause polution. The lead can seep into waterways and damage drinking water and crops. - Low power electric light 12 W CFL - Low Power radio	Dispose of used batteries correctly.
3rd Party charging Storage & Shelf Life		Lead acid batteries do not last forever and need to be stored carefully and replaced when they no longer hold their charge. - Low power electric light 12 W CFL - Low Power radio	
Solar PV 100 Noise	L	Very small noise problem for some types. - Low power electric light 12 W CFL - Low Power radio	Site away from houses.
Solar PV 100 Time to Collect		The wind is free and does not need to be collected. Time can be saved for the householder since they do not need to gather or shop for the fuel. - Low power electric light 12 W CFL - Low Power radio	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #2

Importance **H** = High
M = Medium
L = Low

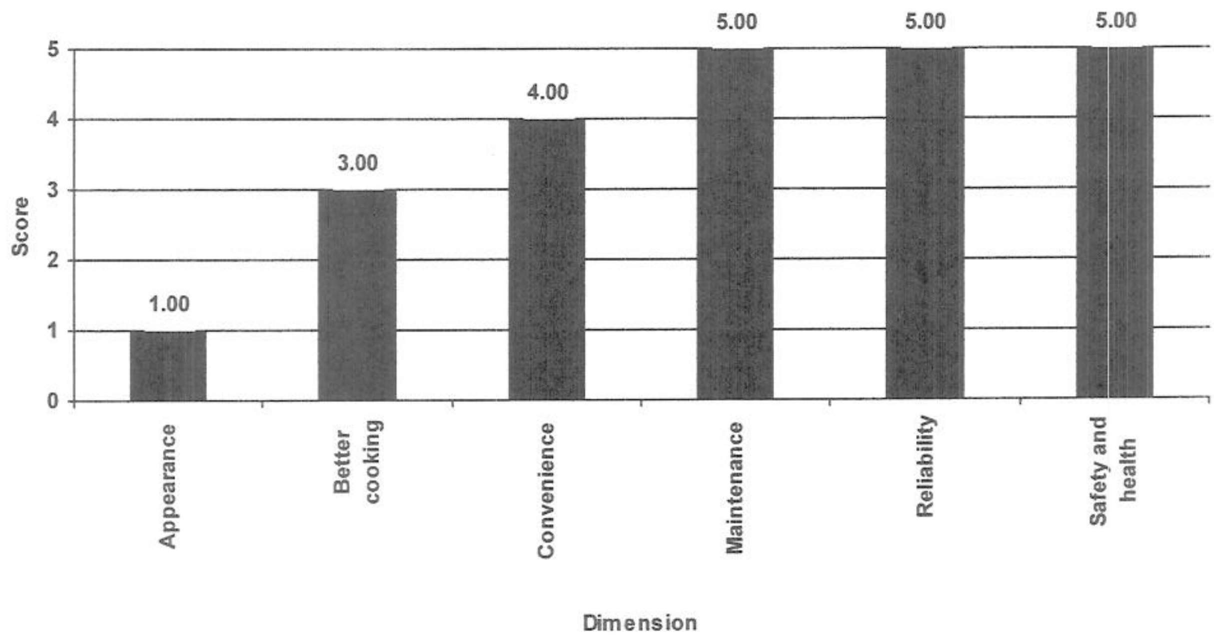
Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
LPG			
Fire	**M**	A low risk of fire occurring exists when this fuel is used. Gas appliances are generally quite safe. - Gas low pressure stove - single	
Poisoning	**L**	Poisonous carbon monoxide can be released if the equipment is not serviced properly - Gas low pressure stove - single	
Storage and shelf life	**M**	The gas is supplied in bulky containers that must be regularly serviced and not overfilled. Transporting the gas in some of the larger bottles without a vehicle can be difficult. - Gas low pressure stove - single	
Suffocation	**L**	Suffocation is a very low risk but this can become serious if appliances are not serviced and they are not stored in a well ventilated area. - Gas low pressure stove - single	
Waste disposal	**L**	The containers for LPG can be reused - Gas low pressure stove - single	

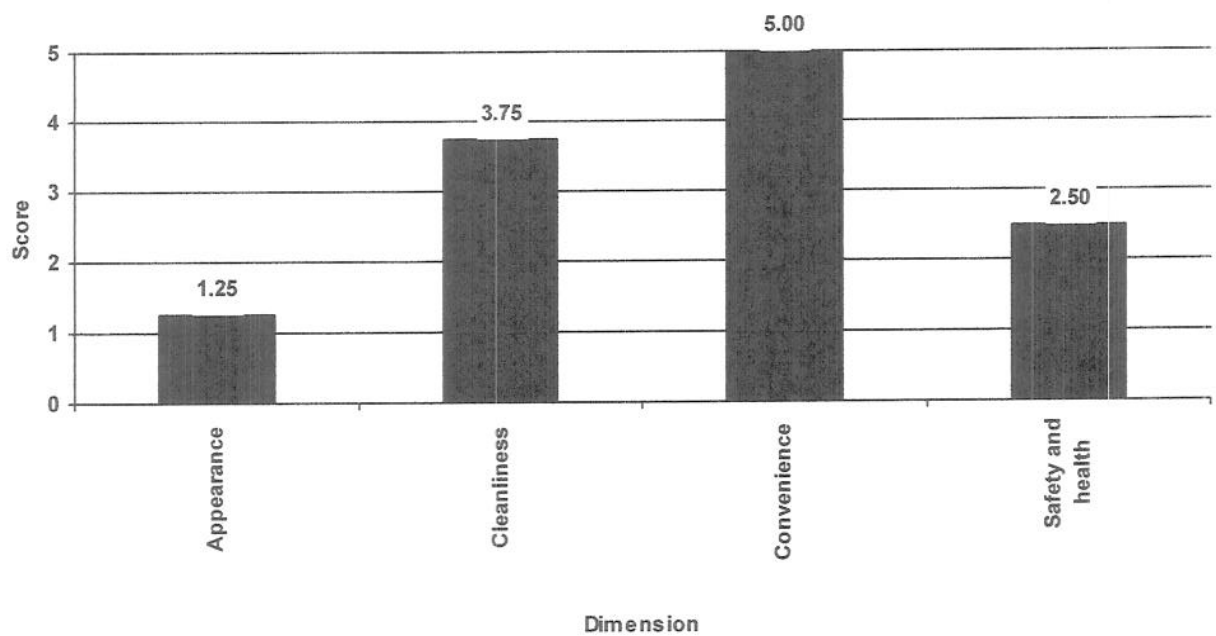
Preference scores

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #2

Hot water Heating water for any purpose, e.g. beverages, dishes, personal, clothes washing.

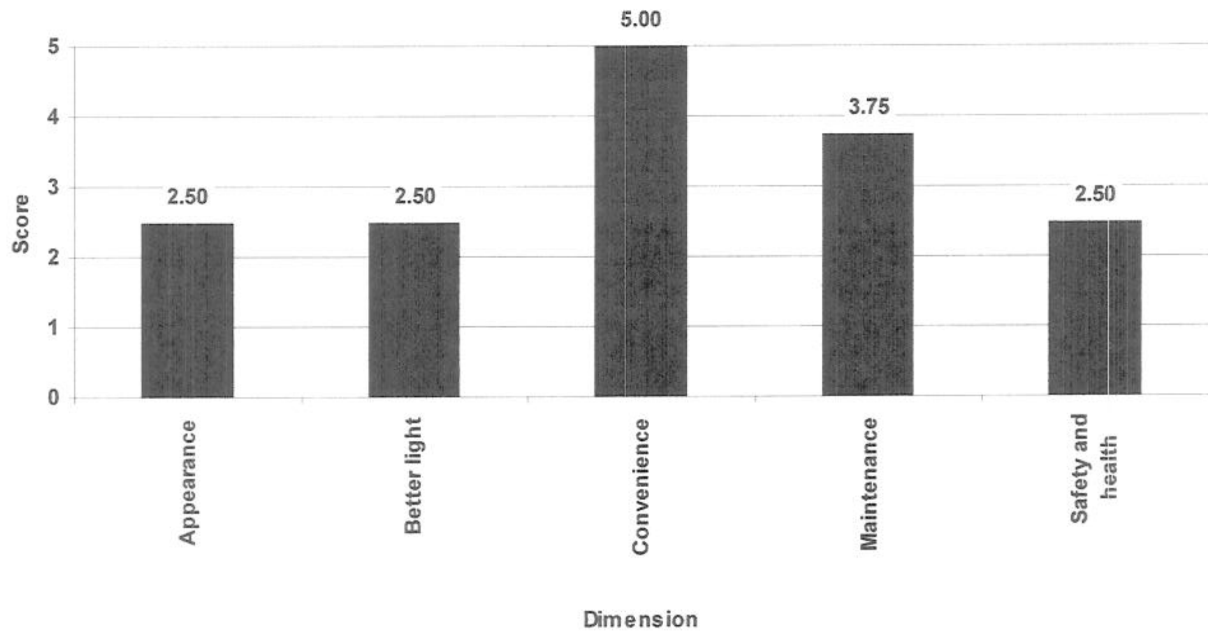


Ironing Heating an iron (any type of iron)



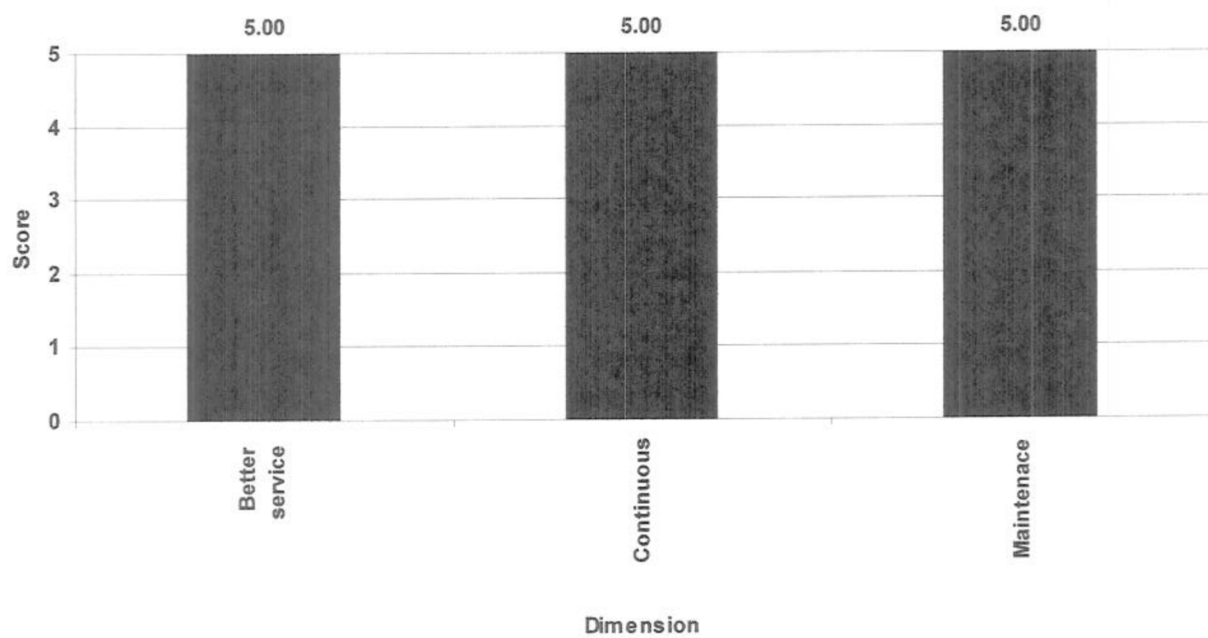
Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #2

Lighting



Media & Other Services

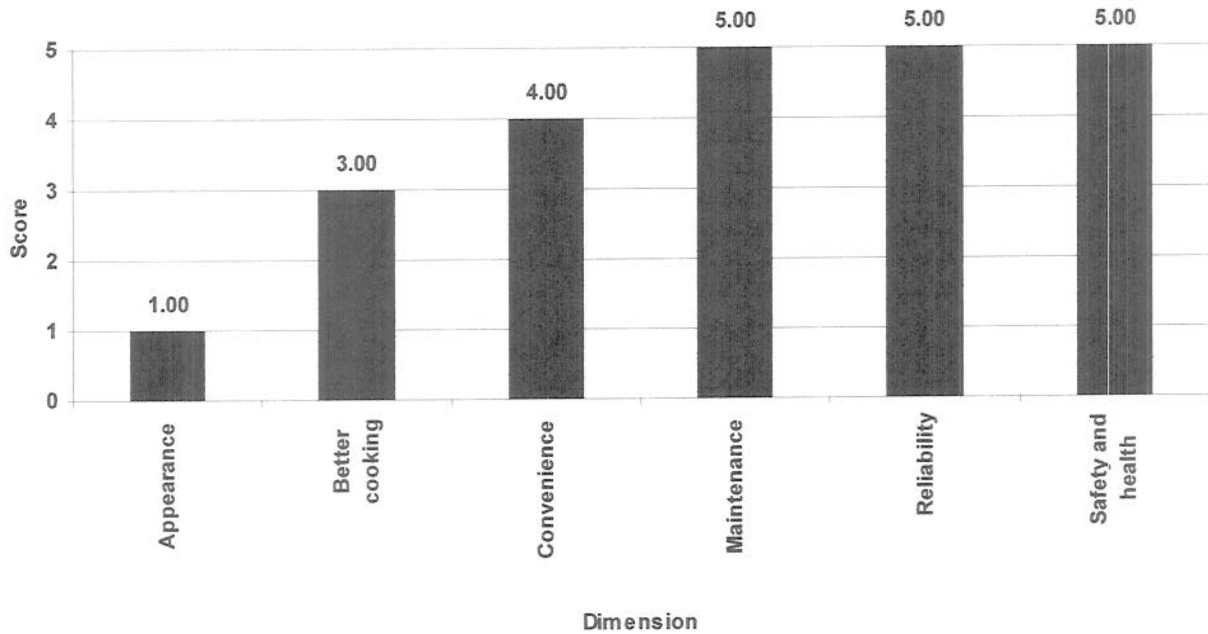
Supply of Electricity for any household appliance, not listed services, e.g. cooking.



Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #2

Plate cooking

Cooking with pots and pans, not grilling or baking



This report shows the average Scores against each Dimension of each Service for the Basket. The Scores take into account the Importance of each Dimension. If the Basket uses more than one Fuel to supply a particular Service then the Scores are the average Score. The Scores are adjusted so that the highest Score for any Dimension is always 5.

Important considerations about fuels

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #3

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import- ance	Comment	Mitigation
High power electr			
Municipal Customer Electrocution	**L/M**	There is a risk of electrocution if guidelines are not followed or the electricity supplied is tampered with. - High power electric light 20 W CFL - High power electric radio	Must be installed by approved persons.
Municipal Customer Exit/switching cost	**M**	There are usually connection fees, standing charges and usage charges associated with this type of electricity. Customers may need to sign a contract with the supplier. - High power electric light 20 W CFL - High power electric radio	
PE Electrocution	**L/M**	There is a risk of electrocution if guidelines are not followed or the electricity supplied is tampered with. - High power electric light 20 W CFL - High power electric radio	Must be installed by approved persons.
PE Exit/switching cost	**M**	There are usually connection fees, standing charges and usage charges associated with this type of electricity. Customers may need to sign a contract with the supplier. - High power electric light 20 W CFL - High power electric radio	
PE Quality of Life	**H**	Electricity can be used for many different types of appliance. - High power electric light 20 W CFL - High power electric radio	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #3

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
LPG			
Fire	M	A low risk of fire occurring exists when this fuel is used. Gas appliances are generally quite safe. - Gas low pressure stove - double	
Poisoning	L	Poisonous carbon monoxide can be released if the equipment is not serviced properly - Gas low pressure stove - double	
Storage and shelf life	M	The gas is supplied in bulky containers that must be regularly serviced and not overfilled. Transporting the gas in some of the larger bottles without a vehicle can be difficult. - Gas low pressure stove - double	
Suffocation	L	Suffocation is a very low risk but this can become serious if appliances are not serviced and they are not stored in a well ventilated area. - Gas low pressure stove - double	
Waste disposal	L	The containers for LPG can be reused - Gas low pressure stove - double	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #3

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

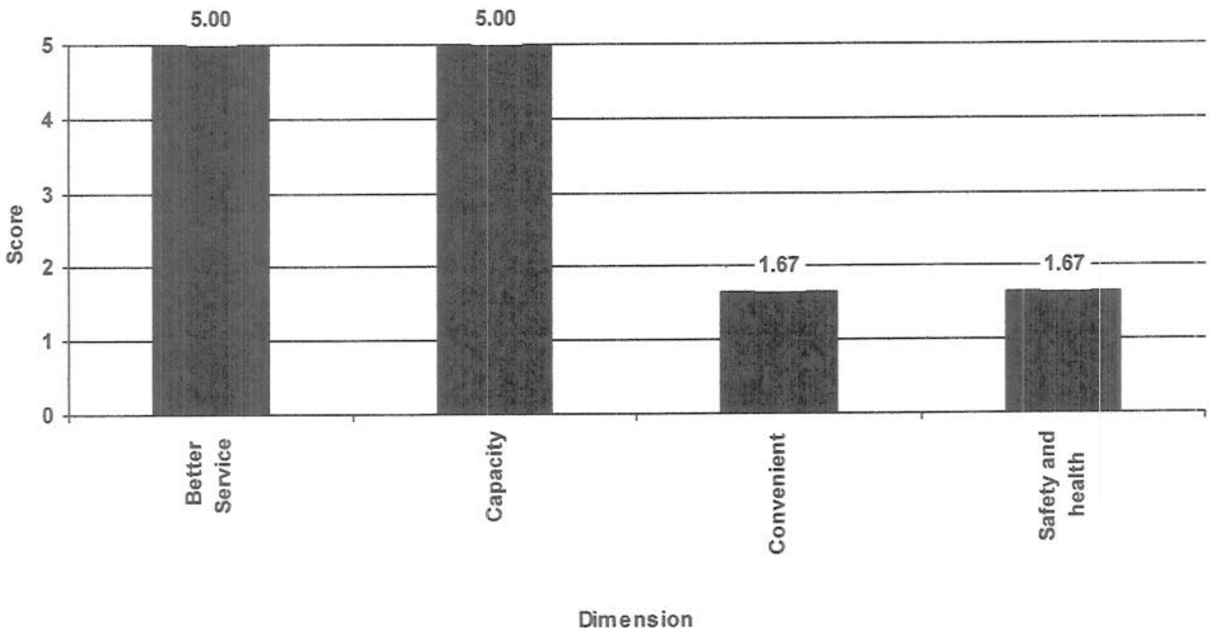
Fuel type Consideration / Device	Import-ance	Comment	Mitigation
Solar-thermal			
Sun Exit/Switching cost		There is not cost to start using sun power. - Solar stove	
Sun Pollution		Using solar power produces no pollution of any kind. - Solar stove	
Sun Quality of Life		Solar power does not produce smoke or other unpleasant fumes. - Solar stove	

Preference scores

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #3

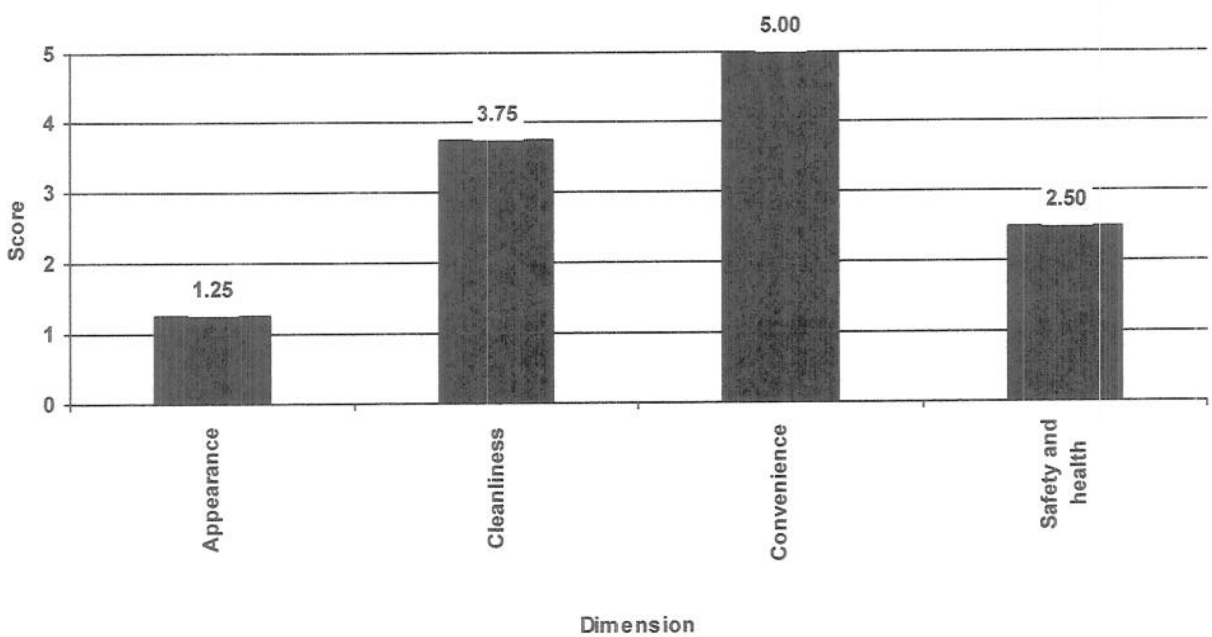
Hot water

Heating water for any purpose, e.g. beverages, dishes, personal, clothes washing.



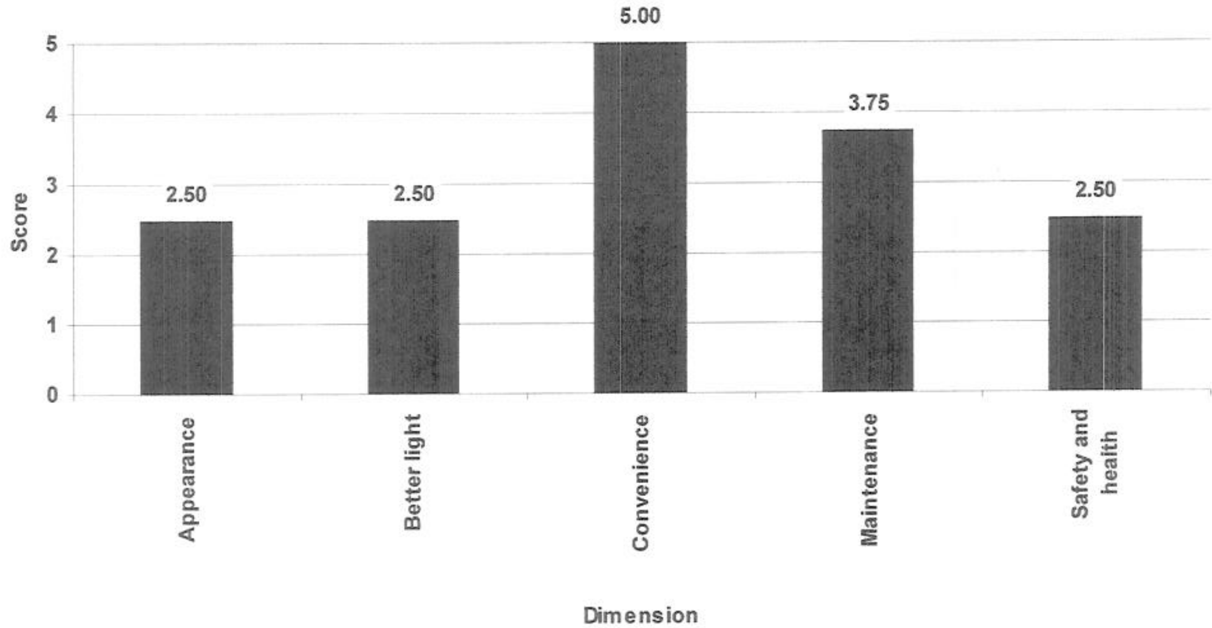
Ironing

Heating an iron (any type of iron)



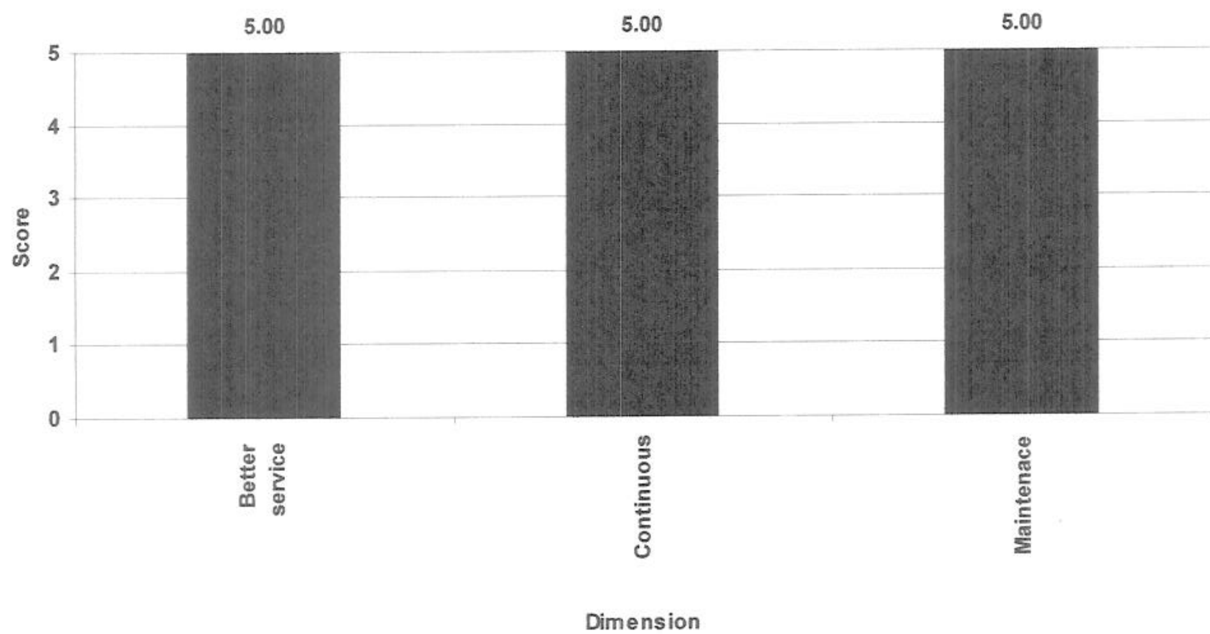
Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low income scenario	**Basket**	Low #3

Lighting



Media & Other Services

Supply of Electricity for any household appliance, not listed services, e.g. cooking.



Appendix G.6.3: “Low Income Demog” & “Low Income & fridge”: Comparing baskets

Basket contents and access cost

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Basket Low #4

No.		Appliance	Unit cost		Total cost		
1 off	**Available** ✓	Low Power radio Plugs into the Pv type 12Volt system	90.00	ea	90.00	total	ZAR
1 off	**Available** ✓	Gas refrigerator (100l) Medium refrigerator	4,227.00	ea	4,227.00	total	ZAR
1 off	**Available** ✓	Solar stove Uses parabolic mirrors to provide concentrated 200 to 400 degrees Celsius heat	600.00	ea	600.00	total	ZAR
1 off	**Available** ✓	Gas low pressure stove - double	240.00	ea	240.00	total	ZAR
3 off	**Available** ✓	Low power electric light 12 W CFL High efficiency bulb	0.00	ea	0.00	total	ZAR

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Total cost of Appliances	**5,157.00**	**ZAR**

Fuel	Fuel access cost	
Solar PV 300	29,700.00	ZAR
LPG	299.71	ZAR
Sun	0.00	ZAR
Total Fuel access cost	**29,999.71**	**ZAR**

Total Basket access cost	**35,156.71**	**ZAR**

Analysis	Okuryangava Study (OK and ON)	Demographic	Low Income Demog
Scenario	Low Income & fridge		

Basket Low #5

No.		Appliance	Unit cost		Total cost		
1 off Available ☑		High power electric radio	170.00	ea	170.00	total	ZAR
1 off Available ☑		Gas refrigerator (100l) Medium refrigerator	4,227.00	ea	4,227.00	total	ZAR
1 off Available ☑		Solar stove Uses parabolic mirrors to provide concentrated 200 to 400 degrees Celsius heat	600.00	ea	600.00	total	ZAR
1 off Available ☑		Gas low pressure stove - double	240.00	ea	240.00	total	ZAR
3 off Available ☑		High power electric light 20 W CFL High efficiency bulb	100.00	ea	300.00	total	ZAR

Total cost of Appliances **5,537.00** ZAR

Fuel	Fuel access cost	
LPG	299.71	ZAR
Sun	0.00	ZAR
PE 2.5 amp	500.00	ZAR
Total Fuel access cost	**799.71**	ZAR

Total Basket access cost **6,336.71** ZAR

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Basket Low #6

No.		Appliance	Unit cost		Total cost		
1	off	High power electric radio	170.00	ea	170.00	total	ZAR
Available ✓							
1	off	High power electric freezer (70l)	1,300.00	ea	1,300.00	total	ZAR
Available ✓							
1	off	Solar stove Uses parabolic mirrors to provide concentrated 200 to 400 degrees Celsius heat	600.00	ea	600.00	total	ZAR
Available ✓							
1	off	Gas low pressure stove - double	240.00	ea	240.00	total	ZAR
Available ✓							
3	off	High power electric light 20 W CFL High efficiency bulb	100.00	ea	300.00	total	ZAR
Available ✓							

Total cost of Appliances **2,610.00** **ZAR**

Fuel	Fuel access cost	
LPG	299.71	ZAR
Sun	0.00	ZAR
PE 2.5 amp	500.00	ZAR

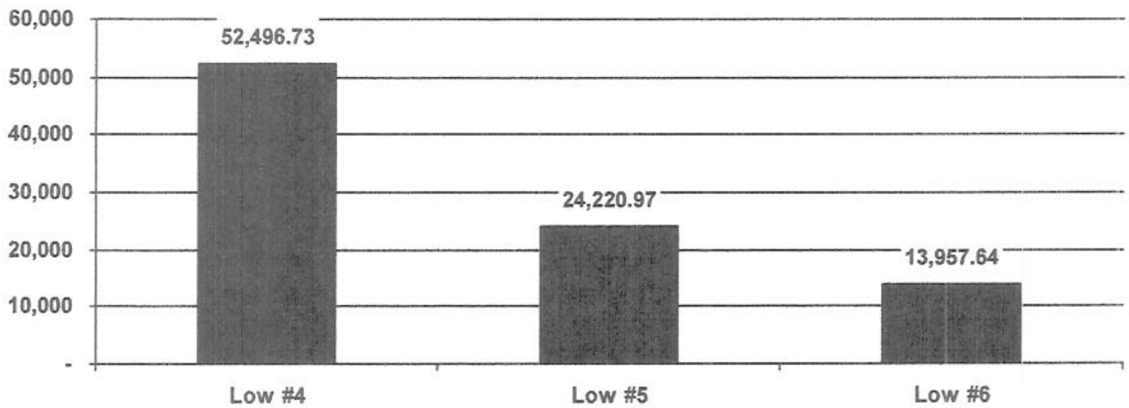
Total Fuel access cost **799.71** **ZAR**

Total Basket access cost **3,409.71** **ZAR**

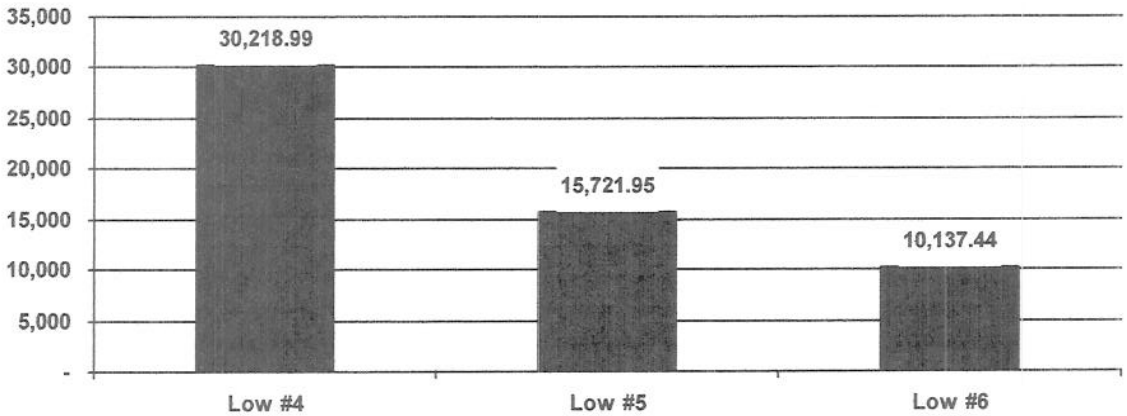
Life-cycle costs

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Life cycle costs based on local survey data



Life cycle costs based on EnPower estimates



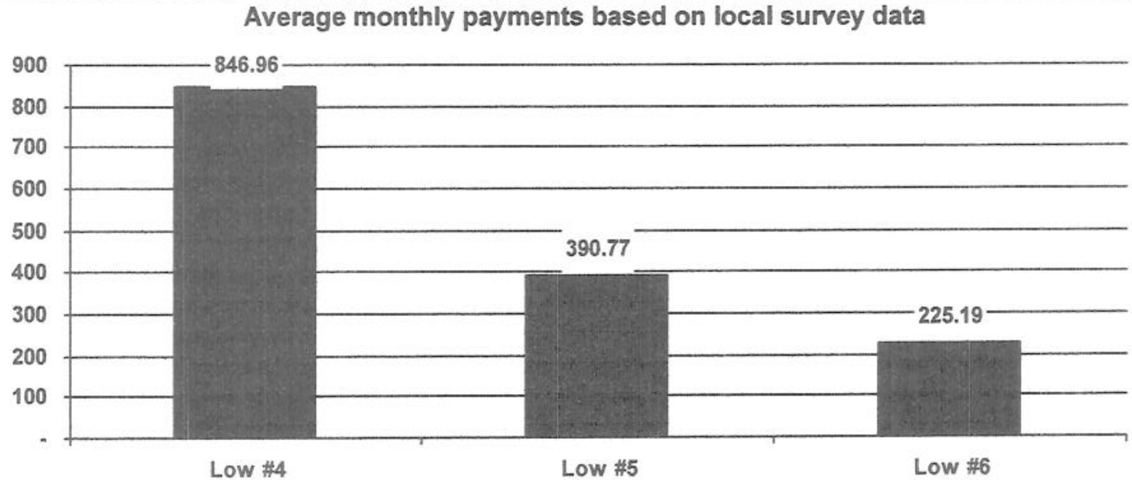
Comparison period 10.0 **years** **Annual discount rate** 15% **All costs in** ZAR

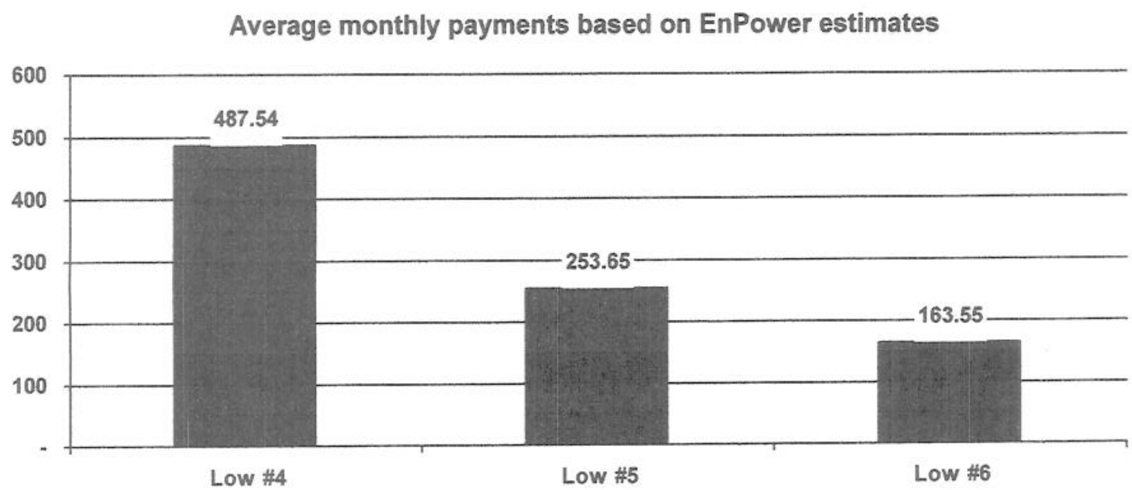
NOTES

Life cycle costs are used to show how much something costs over a defined period. For example an Appliance that is cheap to buy but expensive to run may cost more in the long-term than a more expensive device that is cheaper to run. Life cycle costs are based on a comparison period and a discount rate. See the EnPower guidance for more explanation. Lower life cycle costs mean lower expenditure over the long-term.

Average monthly expenditure

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		



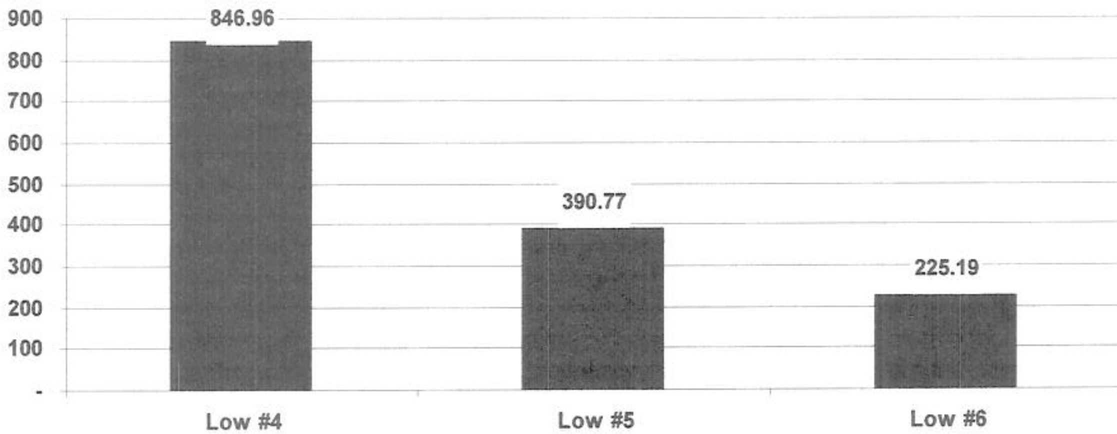


Comparison period 10.0 **years** **Annual discount rate** 15% **All costs in** ZAR

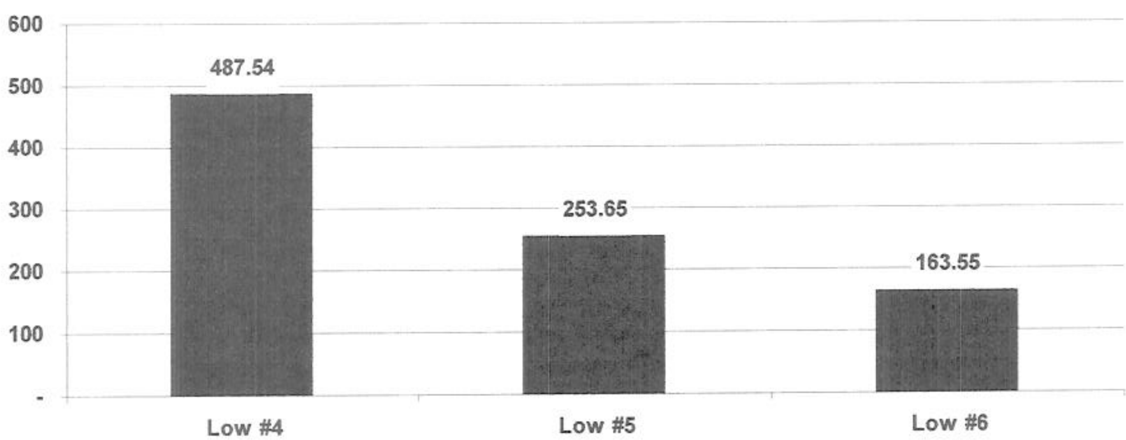
Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

[redacted]

Average monthly payments based on local survey data



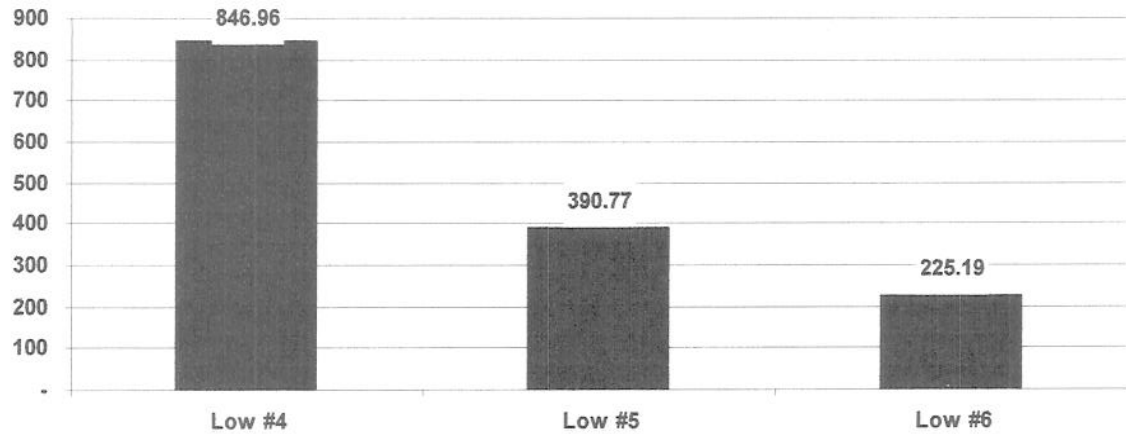
Average monthly payments based on EnPower estimates



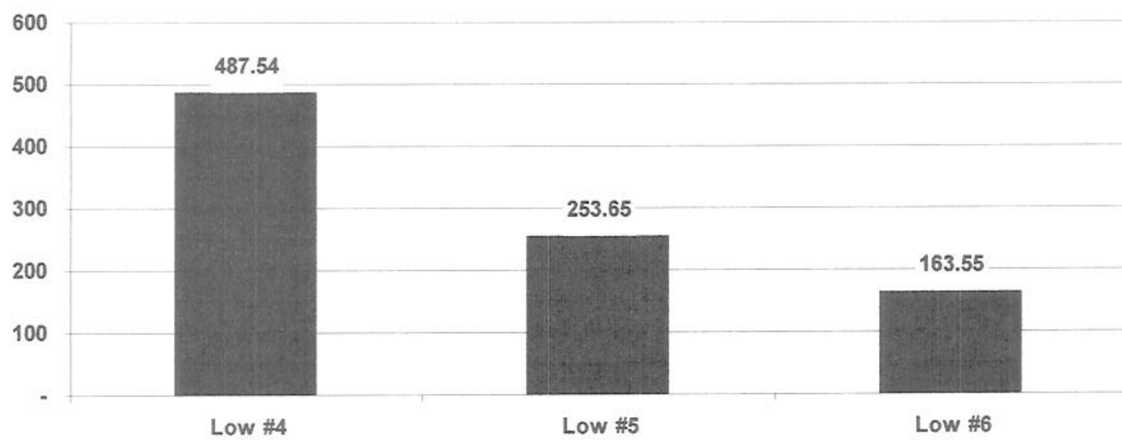
Comparison period 10.0 **years** **Annual discount rate** 15% **All costs in** ZAR

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Average monthly payments based on local survey data



Average monthly payments based on EnPower estimates



Comparison period 10.0 **years** **Annual discount rate** 15% **All costs in** ZAR

NOTES

The monthly costs are calculated from the Present Value of the basket. The Present Value is calculated from the Discount Rate and the Amortisation Period.

This represents the amount of money the Customer would need to spend to buy and run the Basket for all their specified needs. It takes account of the need of the Customer to borrow money and repay it over the Amortisation period at a rate equivalent to the Discount Rate.

This therefore represents the real running costs to the Customer on a consistent and comparable basis in todays money.

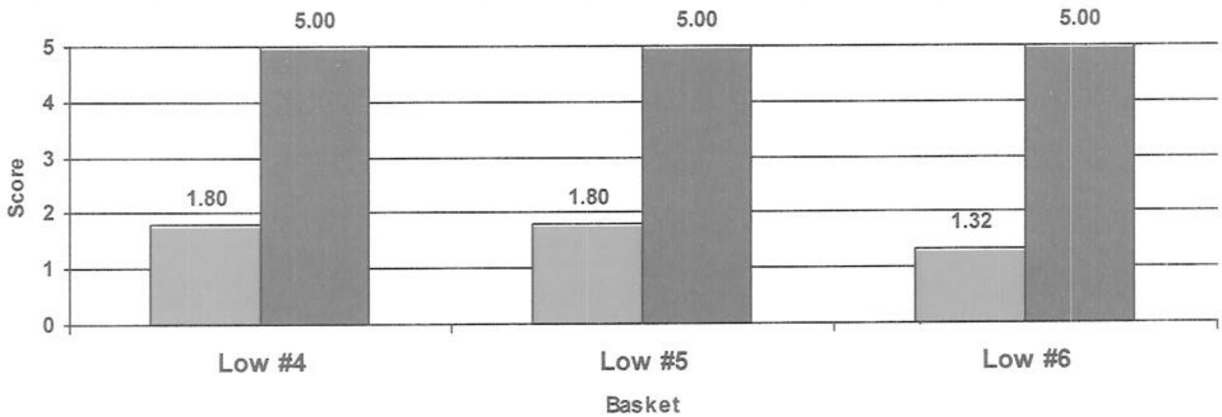
Performance scores

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Quantity Score
Rating score

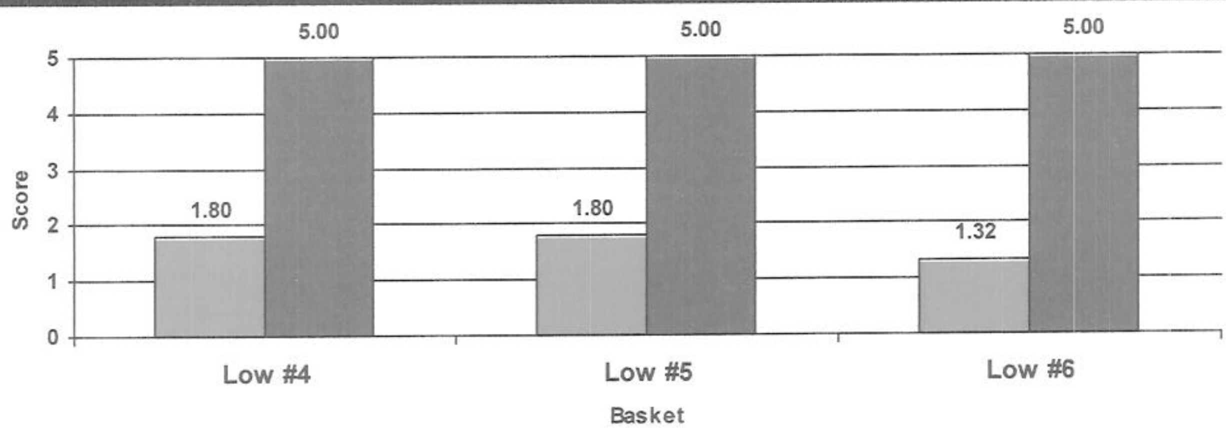
Hot water

Heating water for any purpose, e.g. beverages, dishes, personal, clothes washing.



Ironing

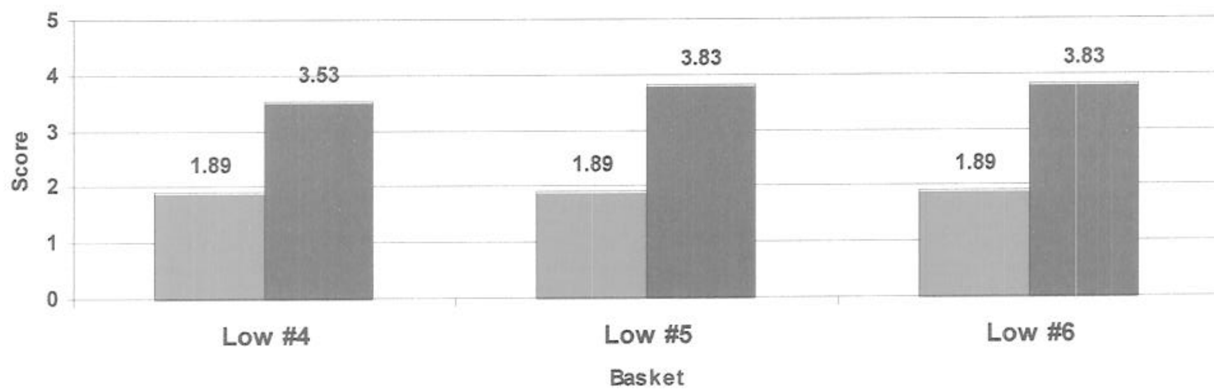
Heating an iron (any type of iron)



Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

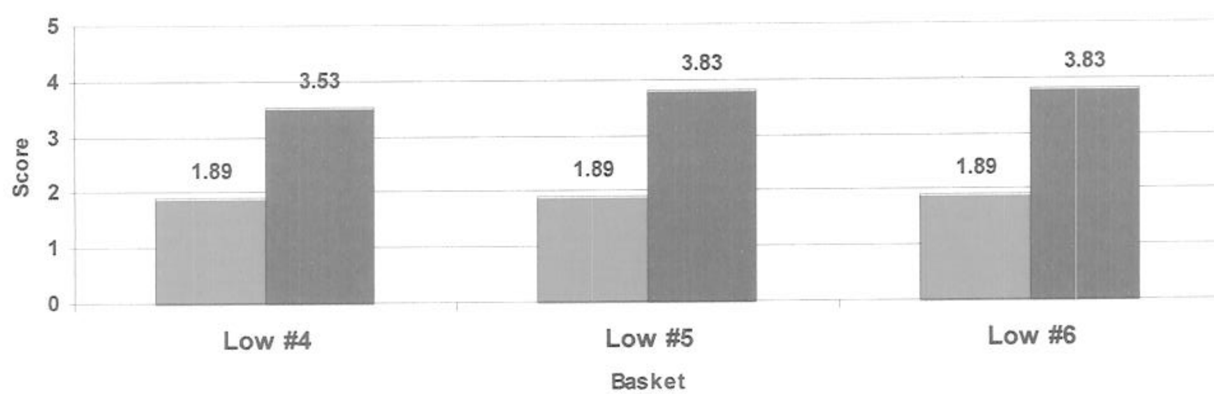
Quantity Score
Rating score

Lighting



Media & Other Services

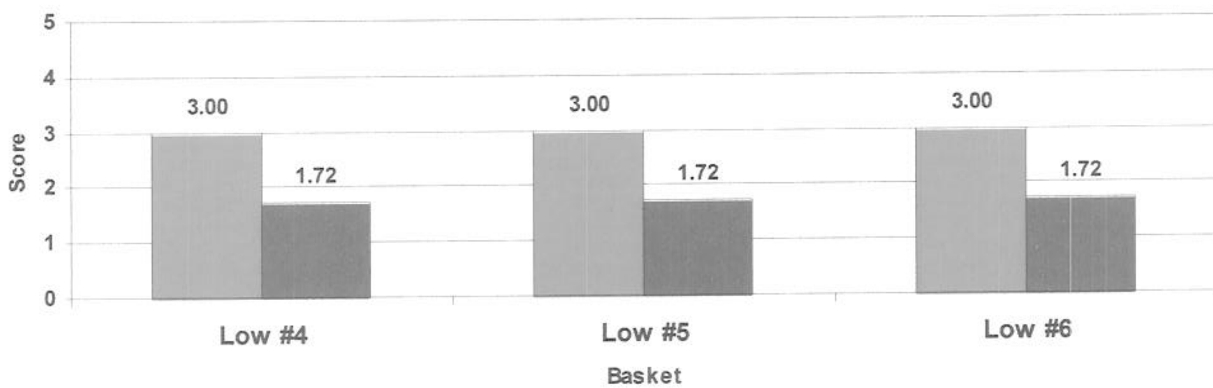
Supply of Electricity for any household appliance, not listed services, e.g. cooking.



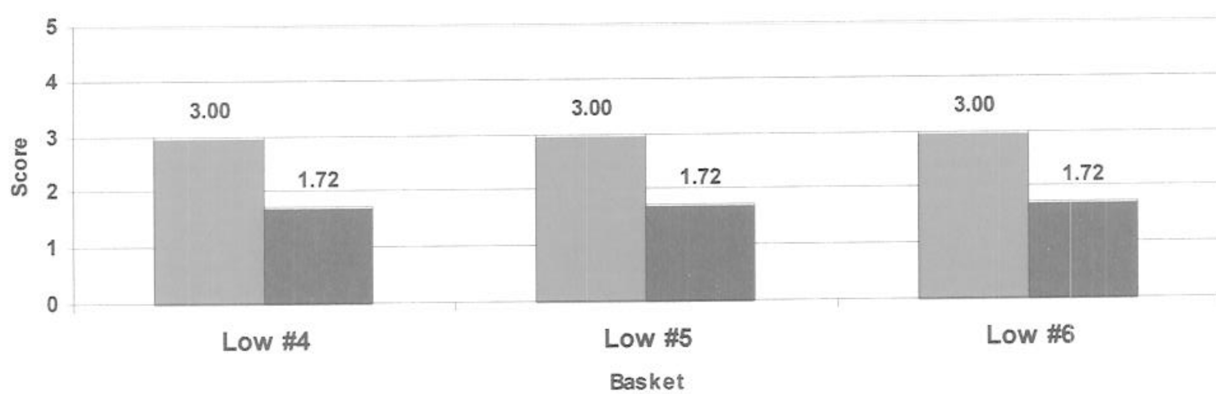
Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Quantity Score
Rating score

Plate cooking Cooking with pots and pans, not grilling or baking



Refrigeration Refrigeration for cooling and storing perishable foodstuff



Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Quantity Score
Rating score

This Report compares different Baskets in terms of their Performance. All of the Baskets shown here provide at least the minimum level of Service. If the Basket meets the mimimum requirement for a Service it gets a Score of 1. If the Basket meets the Maximum requirement the Basket it Scores 5. If the Basket lies somewhere between the minimum and maximum requirement then it Scores somewhere between 1 and 5. The Score depends on the Performance of each Appliance in the Basket that can provide that Service. If the Basket exceeds the maximum requirement it still only Scores a maximum of 5 points.

If a Basket is shown on this form then it is suitable for the Household and will meet their needs. The basket with the highest overall Score is the best Basket in terms of its Performance. The Performance of the Basket must be balanced against its cost, the Householders' Preferences, Environmental Performance etc. See the EnPower Guidance for more information.

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

This report lists the Fuels that are currently used by the Community. This information comes from two different places. The Householders were asked how much Fuel they used each month. This is the 'Surveyed' amount. The householders were also asked what Appliances they used to supply which Services and how much they used them. From this the 'Calculated' Fuel use can be estimated by EnPower.

The top table shows the Fuels that are used, how much they are used and how much they cost. For some Fuel Types we cannot be sure which specific Fuel is used. For example, if the Household uses Low Power electricity then we cannot be sure whether they use Dry Cell Batteries or Lead Acid Batteries for example. All the different options are shown in the top table.

The bottom table takes information from the top table. This table shows the range of Fuel Expenditure by each average Household on each type of Fuel.

Importance of preference dimensions

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Hot water

	Dimension	Importance
1	Better Service	38%
2	Capacity	38%
3	Convenient	13%
4	Safety and health	13%

Ironing

	Dimension	Importance
1	Convenience	40%
2	Cleanliness	30%
3	Safety and health	20%
4	Appearance	10%

Lighting

	Dimension	Importance
1	Convenience	31%
2	Maintenance	23%
3	Appearance	15%
4	Better light	15%
5	Safety and health	15%

Media & Other Services

	Dimension	Importance
1	Better service	33%
2	Continuous	33%
3	Maintenace	33%

Plate cooking

	Dimension	Importance
1	Maintenance	22%
2	Reliability	22%
3	Safety and health	22%
4	Convenience	17%
5	Better cooking	13%
6	Appearance	4%

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Refrigeration

	Dimension	Importance
1	Appearance	25%
2	Maintenance	25%
3	Reliability	25%
4	Safety and health	25%

This report lists the Dimensions the Services required by the Community. It shows the relative importance of the Dimensions based on the information provided by the Community. In each case the most important Dimensions are at the top of the list. This report does not however make any judgements on the relative importance of the different Services.

Basket environmental impact

Analysis Okuryangava Study (OK and ON) **Demographic** Low Income Demog

Scenario Low Income & fridge

Basket Low #4

Fuel		Annual household emmissions [kg/year]		
		CO2	SO2	NOx
Low Power Elec	Solar PV 300	0 - 0	0 - 0	0 - 0
LPG		0 - 0	0 - 0	0 - 0
Solar-thermal	Sun	0 - 0	0 - 0	0 - 0
	Total	**0 - 0**	**0 - 0**	**0 - 0**

Basket Low #5

Fuel		Annual household emmissions [kg/year]		
		CO2	SO2	NOx
High power electricity	PE 2.5 amp	0 - 0	0 - 0	0 - 0
LPG		0 - 0	0 - 0	0 - 0
Solar-thermal	Sun	0 - 0	0 - 0	0 - 0
	Total	**0 - 0**	**0 - 0**	**0 - 0**

Basket Low #6

Fuel		Annual household emmissions [kg/year]		
		CO2	SO2	NOx
High power electricity	PE 2.5 amp	0 - 0	0 - 0	0 - 0
LPG		0 - 0	0 - 0	0 - 0
Solar-thermal	Sun	0 - 0	0 - 0	0 - 0
	Total	**0 - 0**	**0 - 0**	**0 - 0**

This report estimates the amount of emissions of carbon dioxide (CO_2), sulphur dioxide (SO_2) and nitrogen oxides (NO_x) that would be resleased into the atmosphere by the users of these baskets. This gives an idea as to which basket has the highest environmental impact. High numbers mean a higher level of impact. This information may be interesting to Stakeholders who are concerned about the environment.

Scenario details (Part 1)

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Analysis name	Okuryangava Study		
Community	OK and ON		
Location	Okuryangava		
Region	Khomas Region		
Country	South Africa	**Currency**	South African Rand (ZAR)
Community description	Okahandja Park (OK) and Ongulumbashe (ON) are situated within Okuryangava, 15 minutes north of Windhoek. Okuryangava consists of 300-400 households. The occupants are peri-urban poor, where mostly the women work as domestic workers.		
Analysis comment	The Okuryangava village was selected and engaged through the EnPower process and analysed according to the EnPower research framework and algorthim. We three WPI students will be evaluating the process according to our developed criteria.		
Demographic name	Low Income Demog		
Demograhpic description	Separate analysis for the lowest economic segment of the community. Represented by those houdeholds earning less than R1100 per month.		
No. households	23		
Scenario name	Low Income & fridge		
Scenario description	Low income with additional fridge option		
Comparison period	10 years		
Discount rate	15.00%		
Comment	Okuryangava: 15% is the suggested value from the manual		
DataSource	Imported from Data Collation Tool		

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Present Basket

Appliance

Candle Holder	Standard candle holder
Dry cell battery radio	
Gas low pressure stove - double	
Gas low pressure stove - single	
Low Power radio	Plugs into the Pv type 12Volt system
Low-power electric television	For use with a low-power electricity supply, not batteries
Paraffin lamp - regular	
Paraffin stove - wick double plate	
Paraffin wick stove - low cost single	
Wood fire (open)	Typical fire used for cooking
Wood stove - pressed steel	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Present Fuel Use

Fuel	Quantity Used	
Candles	1.00	kg/day
Dry Cell Battery	47.78	Vah/day
Low Power Elec	35.22	Vah/day
LPG	3.74	kg/day
Paraffin	6.13	l/day
Wood	93.02	kg/day

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Present Service Use

Appliance	Service	Yearly use		Pen.
Candle Holder	General lighting	1,249	light sources.hours/year	78%
Dry cell battery radio	Radio	1,283	N/A.hours/year	43%
Gas low pressure stove - double	Medium heat	1,916	hot plates.hours/year	26%
Gas low pressure stove - double	Ironing	52	irons.hours/year	4%
Gas low pressure stove - double	Warm washing water	228	litres.litres/year	9%
Gas low pressure stove - double	Rapid heating or frying	168	hot plates.hours/year	4%
Gas low pressure stove - double	Boiling water any purpose	1,168	litres.litres/year	22%
Gas low pressure stove - single	Boiling water any purpose	7,300	litres.litres/year	4%
Gas low pressure stove - single	Medium heat	1,095	hot plates.hours/year	4%
Gas low pressure stove - single	Ironing	52	irons.hours/year	4%
Low Power radio	Radio	1,356	N/A.hours/year	17%
Low-power electric television	Television	312	N/A.hours/year	4%
Paraffin lamp - regular	General lighting	1,348	light sources.hours/year	57%
Paraffin stove - wick double plate	Medium heat	1,806	hot plates.hours/year	17%
Paraffin stove - wick double plate	Warm washing water	1,851	litres.litres/year	17%
Paraffin stove - wick double plate	Boiling water any purpose	759	litres.litres/year	17%
Paraffin wick stove - low cost single	Rapid heating or frying	338	hot plates.hours/year	4%
Paraffin wick stove - low cost single	Warm washing water	5,475	litres.litres/year	4%
Paraffin wick stove - low cost single	Boiling water any purpose	365	litres.litres/year	4%
Paraffin wick stove - low cost single	Medium heat	730	hot plates.hours/year	9%
Wood fire (open)	Simmering	2,920	hot plates.hours/year	4%
Wood fire (open)	Baking food	153	litres.hours/year	22%
Wood fire (open)	Medium heat	1,269	hot plates.hours/year	52%
Wood fire (open)	Ironing	66	irons.hours/year	61%
Wood fire (open)	Warm washing water	2,315	litres.litres/year	26%
Wood fire (open)	Boiling water any purpose	735	litres.litres/year	48%
Wood stove - pressed steel	Warm washing water	208	litres.litres/year	4%
Wood stove - pressed steel	Baking food	260	litres.hours/year	4%
Wood stove - pressed steel	Boiling water any purpose	1,460	litres.litres/year	4%
Wood stove - pressed steel	Ironing	52	irons.hours/year	4%
Wood stove - pressed steel	Medium heat	6,570	hot plates.hours/year	4%

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Present Fuel Use Check

Fuel	Surveyed	Calculated	Units	Difference
Candles	1.002	0.978	kg/day	-2%
Dry Cell Battery	47.778	46.476	Vah/day	-3%
Low Power Elec	35.217	33.210	Vah/day	-6%
LPG	3.739	3.989	kg/day	6%
Paraffin	6.130	6.538	l/day	6%
Wood	93.023	97.378	kg/day	4%

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Present Service Quantities

Service	Quantity	
Baking	4.16667	litres
Hot water	7.63044	litres
Ironing	1	irons
Lighting	2.30435	light sources
Media & Other Services	1	N/A
Plate cooking	2.39130	hot plates
Refrigeration	100	litres
Space heating	1	sources

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Local Appliance Costs (only Appliances Available Locally)

Available Appliance	Local Cost (ZAR)
Solar lantern	2,300.00
Low power electric light 12 W CFL	0.00
High power electric light 20 W CFL	100.00
High power electric light 60W incandescent	54.00
Wood Evat stove	150.00
High power electric double plate cooker	200.00
Gas low pressure stove - single	40.00
Gas low pressure stove - double	240.00
Solar stove	600.00
Solar box cooker	700.00
High power electric freezer (70l)	1,300.00
High power electric refrig. with freezer (190l)	1,650.00
Gas refrigerator (100l)	4,227.00
High power electric Iron	170.00
Low Power radio	90.00
Low power electricity refrigerator	1,500.00
Low-power electric television	314.00
Wind up/solar radio on on manual winding	330.00
Dry cell battery radio	90.00
High power electric television	1,379.00
High power electric radio	170.00

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Scenario details (Part 2)

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Service Requirements

Service type	Min	Max		Min	Max	
Hot water	1	1	litres	1	1	N/A
Ironing	1	3	irons	1	1	N/A
Lighting	1	10	light sources	45	1000	lumen @ 1m
Media & Other Services	1	1	N/A	1	1	N/A
Plate cooking	1	5	hot plates	0.25	5	total kW heat output
Refrigeration	50	300	litres	1	1	N/A

Analysis	Okuryangava Study (OK and ON)
Scenario	Low Income & fridge
Demographic	Low Income Demog

Service Usage (Required Services only)

	Service	Quantity		Use	
Hot water	Boiling water any purpose	1	litres	3.5	litres/day
Hot water	Warm washing water	1	litres	4	litres/day
Ironing	Ironing	1	irons	1	hours/day
Lighting	General lighting	3	light sources	2.3	hours/day
Media & Other Services	Radio	1	N/A	3	hours/day
Plate cooking	Medium heat	2	hot plates	2.75	hours/day
Refrigeration	Refrigerating food	100	litres	24	hours/day

Scenario summary

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge		

Analysis name	Okuryangava Study
Community	OK and ON
Location	Okuryangava
Region	Khomas Region
Country	South Africa
Community description	Okahandja Park (OK) and Ongulumbashe (ON) are situated within Okuryangava, 15 minutes north of Windhoek. Okuryangava consists of 300-400 households. The occupants are peri-urban poor, where mostly the women work as domestic workers.
Analysis comment	The Okuryangava village was selected and engaged through the EnPower process and analysed according to the EnPower research framework and algorthim. We three WPI students will be evaluating the process according to our developed criteria.
Demographic name	Low Income Demog
No. households	23
Scenario name	Low Income & fridge
Demograhpic description	Separate analysis for the lowest economic segment of the community. Represented by those houdeholds earning less than R1100 per month.
Scenario description	Low income with additional fridge option
Discount rate	15.00%
Comment	Okuryangava: 15% is the suggested value from the manual
Comparison period	10

Present and future benefits comparison

Analysis	Okuryangava Study (OK and ON)	Demographic	Low Income Demog
Scenario	Low Income & fridge		

Present and future benefits comparison

Service type	Service	Present [/year]	Future [/year]	Change	Units
Baking	Baking food	44	0	(-100%)	hours/year
Hot water	Boiling water any purpose	1,134	1,278	(+13%)	litres/year
Hot water	Warm washing water	1,193	1,460	(+22%)	litres/year
Ironing	Ironing	47	52	(+10%)	hours/year
Lighting	Close lighting	0	2,190	-	hours/year
Lighting	General lighting	1,740	2,518	(+45%)	hours/year
Media & Other Services	Radio	793	1,095	(+38%)	hours/year
Media & Other Services	Television	14	0	(-100%)	hours/year
Plate cooking	Medium heat	1,873	2,008	(+7%)	hours/year
Plate cooking	Rapid heating or frying	22	0	(-100%)	hours/year
Plate cooking	Simmering	127	0	(-100%)	hours/year
Refrigeration	Refrigerating food	0	876,000	-	hours/year

This report shows a comparison of the Present Benefits received by the community compared to those they will receive in the Future. A Benefit is the delivery of some Service, such as the number of portions of food, or the total number of hours of lighting. The basis of comparison depends on the Service. The numbers above are the total number of Benefits received by a Household each year. Also shown is the change between the past and the future. This is shown as a percentage increase (e.g. +10%) or decrease (e.g. -10%).

Appendix G.6.4: "Low Income Demog" & "Low Income& fridge": Individual baskets

Important considerations about fuels

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge	**Basket**	Low #4

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
Low Power Elec			
3rd Party charging Poisoning	M	The lead in the batteries is toxic and there is a risk of poisoning. This is especially dangerous to children and pregnant women, can cause brain damage and metabolic disorders. - Low power electric light 12 W CFL - Low Power radio	Read the instructions and keep away from children.
3rd Party charging Pollution	M	If these batteries are not disposed of carefully they can cause polution. The lead can seep into waterways and damage drinking water and crops. - Low power electric light 12 W CFL - Low Power radio	Dispose of used batteries correctly.
3rd Party charging Storage & Shelf Life		Lead acid batteries do not last forever and need to be stored carefully and replaced when they no longer hold their charge. - Low power electric light 12 W CFL - Low Power radio	
Solar PV 100 Noise	L	Very small noise problem for some types. - Low power electric light 12 W CFL - Low Power radio	Site away from houses.
Solar PV 100 Time to Collect		The wind is free and does not need to be collected. Time can be saved for the householder since they do not need to gather or shop for the fuel. - Low power electric light 12 W CFL - Low Power radio	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge	**Basket**	Low #4

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
Solar PV 300 Limited current		Can only supply a limited current and cannot be used with high power devices - Low power electric light 12 W CFL - Low Power radio	
Solar PV 300 Limited use		Limited amount of time can be used per day 4 hours of lighting and/or radio - Low power electric light 12 W CFL - Low Power radio	
Solar PV 300 Not for cooking		It is not possible to use electric cookers with photovoltaic power - Low power electric light 12 W CFL - Low Power radio	
Solar PV 300 Time to Collect		The sun is free and does not need to be collected. Time can be saved for the householder since they do not need to gather or shop for the fuel. - Low power electric light 12 W CFL - Low Power radio	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge	**Basket**	Low #4

Importance **H** = High, **M** = Medium, **L** = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
LPG			
Fire	M	A low risk of fire occurring exists when this fuel is used. Gas appliances are generally quite safe. - Gas low pressure stove - double - Gas refrigerator (100l)	
Poisoning	L	Poisonous carbon monoxide can be released if the equipment is not serviced properly - Gas low pressure stove - double - Gas refrigerator (100l)	
Storage and shelf life	M	The gas is supplied in bulky containers that must be regularly serviced and not overfilled. Transporting the gas in some of the larger bottles without a vehicle can be difficult. - Gas low pressure stove - double - Gas refrigerator (100l)	
Suffocation	L	Suffocation is a very low risk but this can become serious if appliances are not serviced and they are not stored in a well ventilated area. - Gas low pressure stove - double - Gas refrigerator (100l)	
Waste disposal	L	The containers for LPG can be reused - Gas low pressure stove - double - Gas refrigerator (100l)	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge	**Basket**	Low #4

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

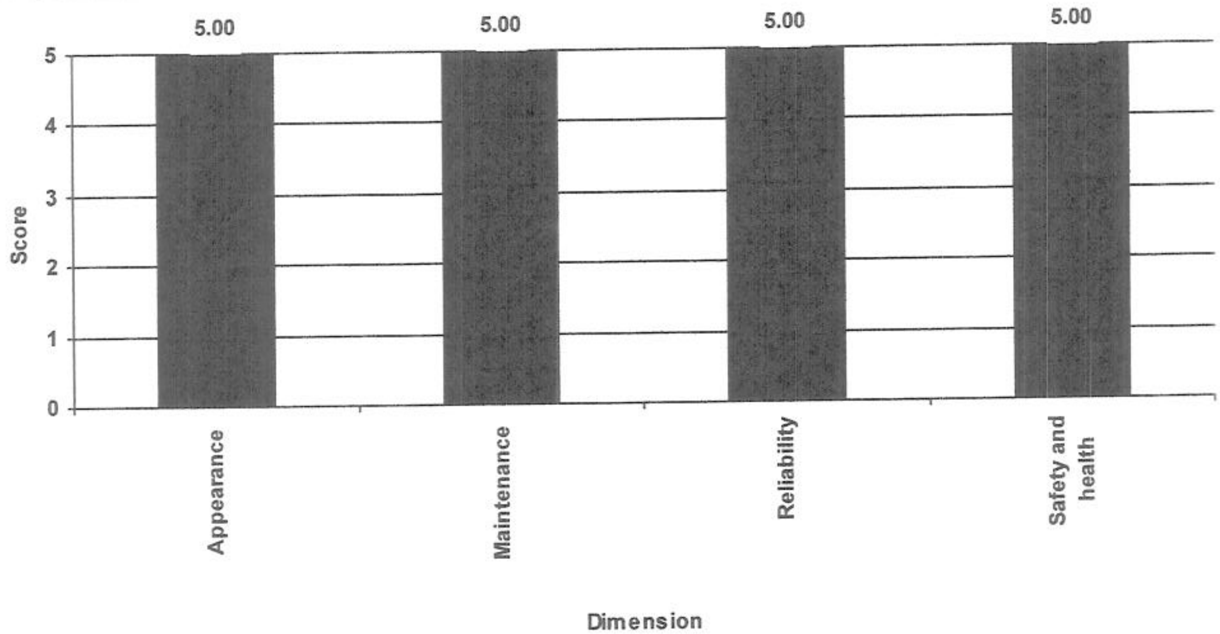
Fuel type Consideration / Device	Import-ance	Comment	Mitigation
Solar-thermal			
Sun Exit/Switching cost		There is not cost to start using sun power. - Solar stove	
Sun Pollution		Using solar power produces no pollution of any kind. - Solar stove	
Sun Quality of Life		Solar power does not produce smoke or other unpleasant fumes. - Solar stove	

Preference scores

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge	**Basket**	Low #4

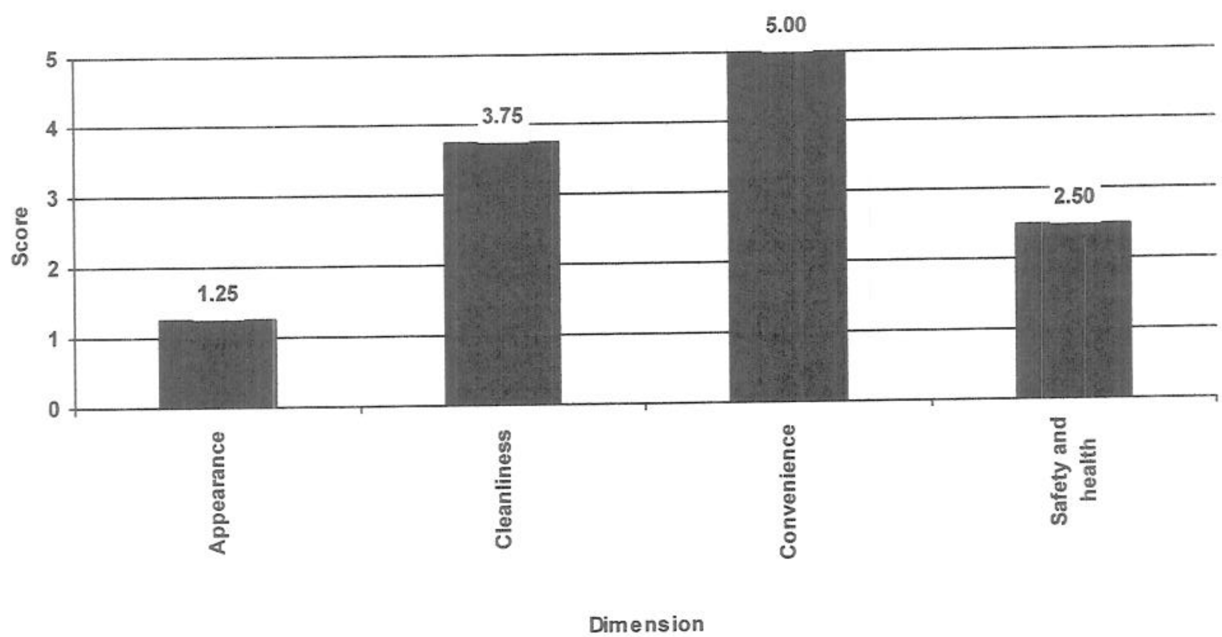
Hot water

Heating water for any purpose, e.g. beverages, dishes, personal, clothes washing.



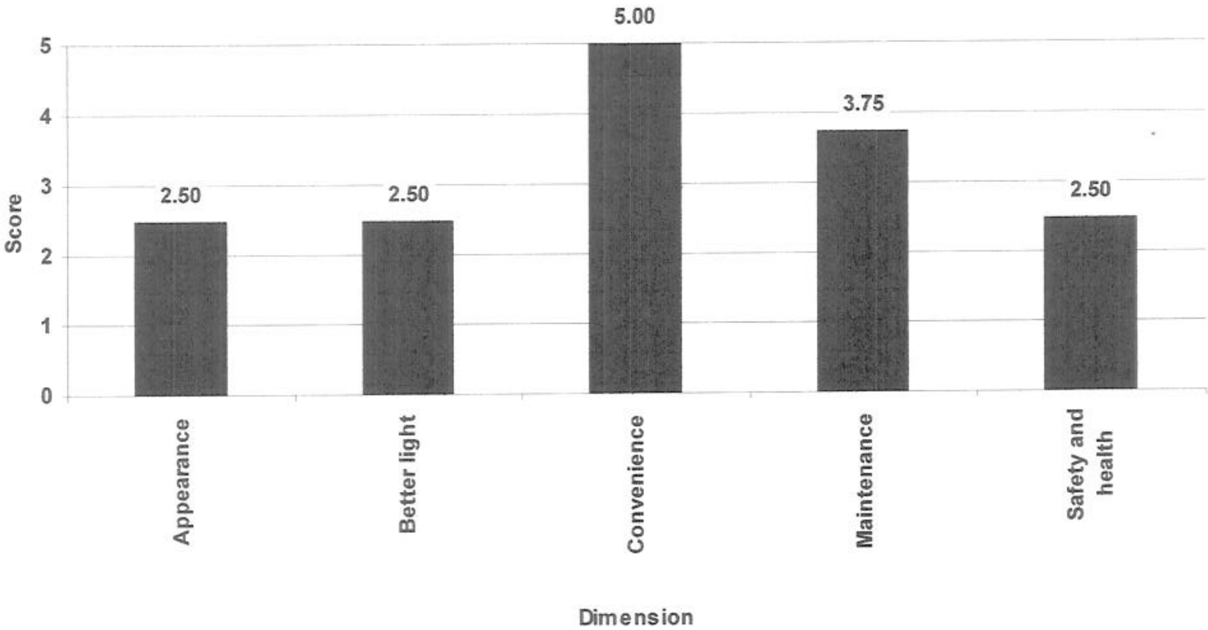
Ironing

Heating an iron (any type of iron)



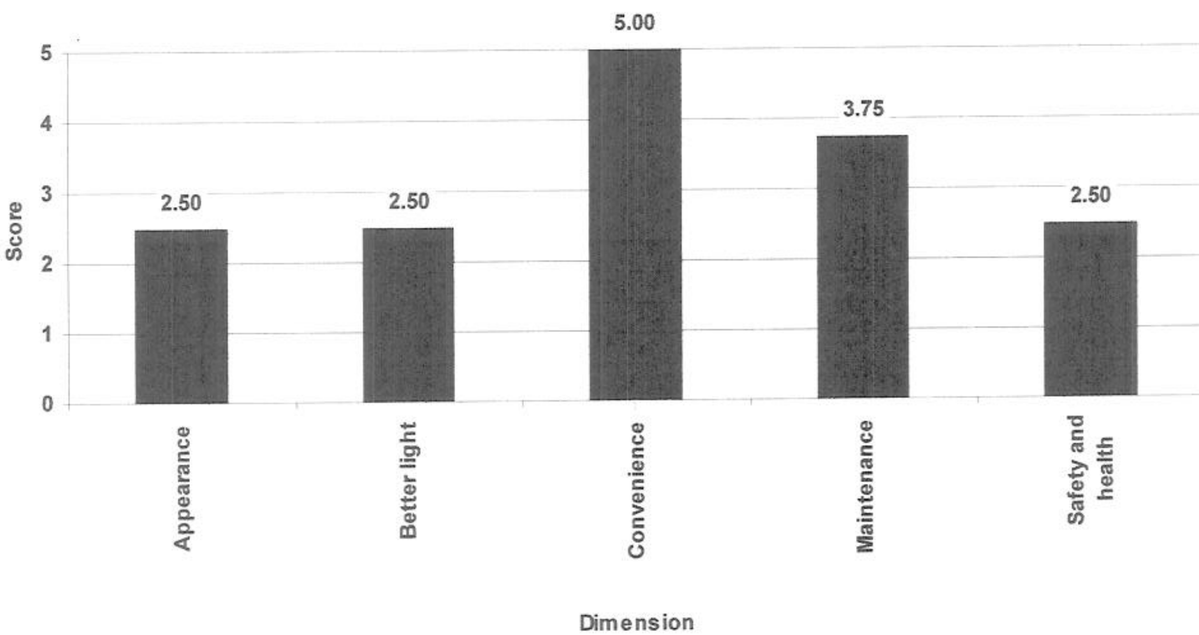
Analysis	Okuryangava Study (OK and ON)	Demographic	Low Income Demog
Scenario	Low Income & fridge	Basket	Low #5

Lighting



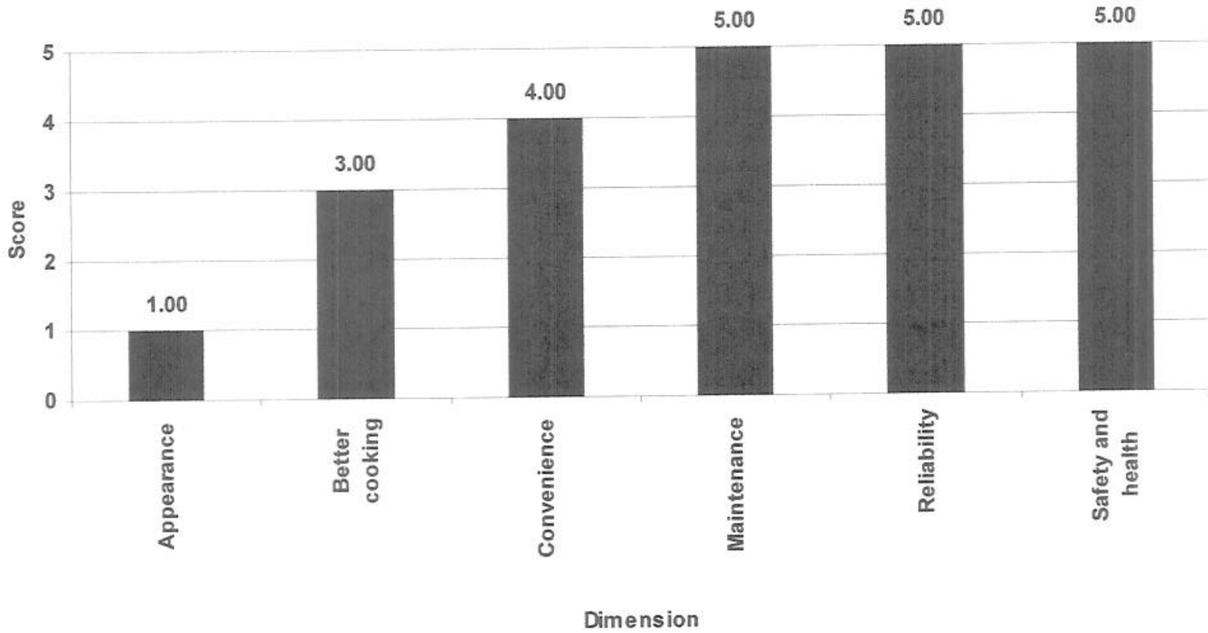
Media & Other Services

Supply of Electricity for any household appliance, not listed services, e.g. cooking.

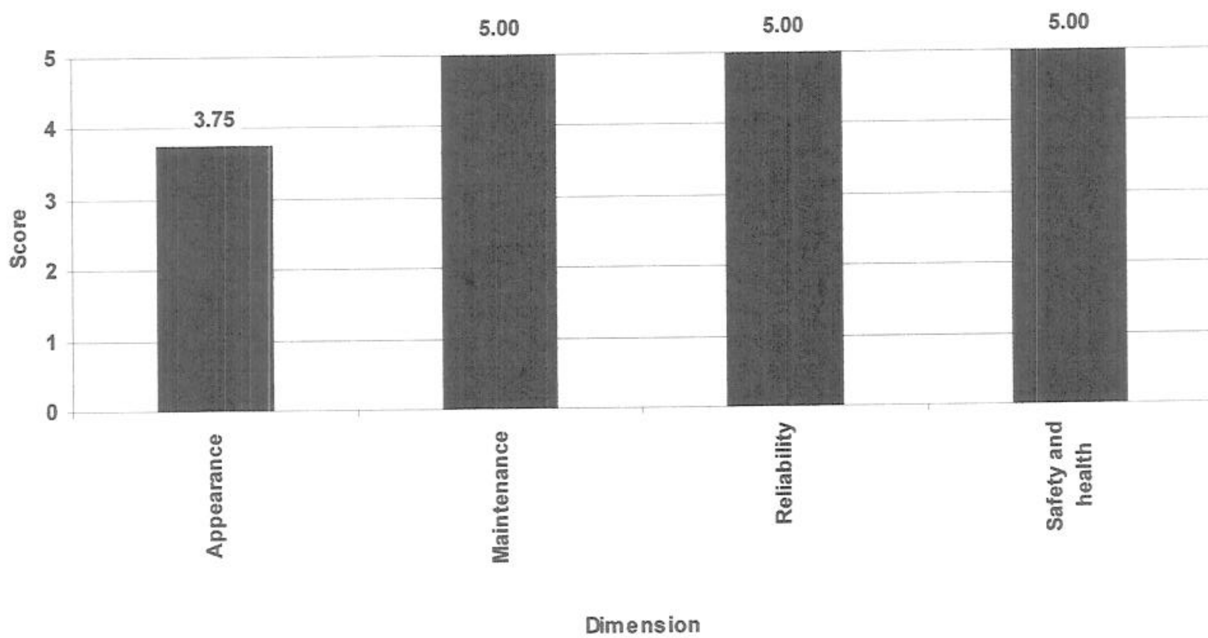


Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge	**Basket**	Low #5

Plate cooking — Cooking with pots and pans, not grilling or baking



Refrigeration — Refrigeration for cooling and storing perishable foodstuff



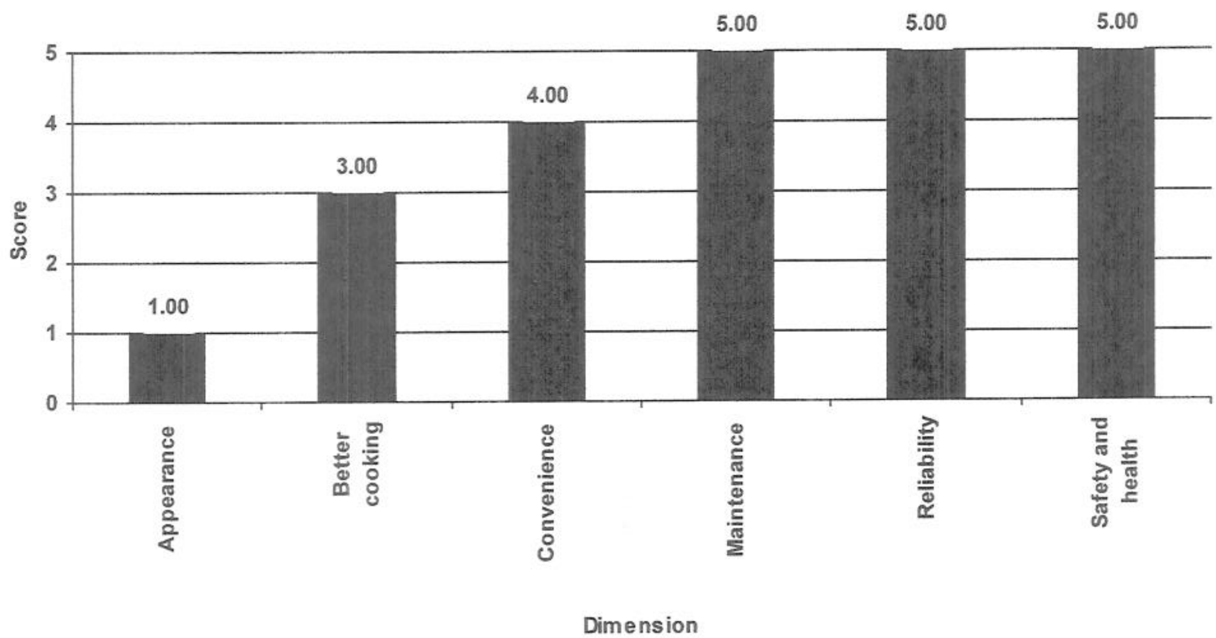
This report shows the average Scores against each Dimension of each Service for the Basket. The Scores take into account the Importance of each Dimension. If the Basket uses more than one Fuel to supply a particular Service then the Scores are the average Score. The Scores are adjusted so that the highest Score for any Dimension is always 5.

Preference scores

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge	**Basket**	Low #6

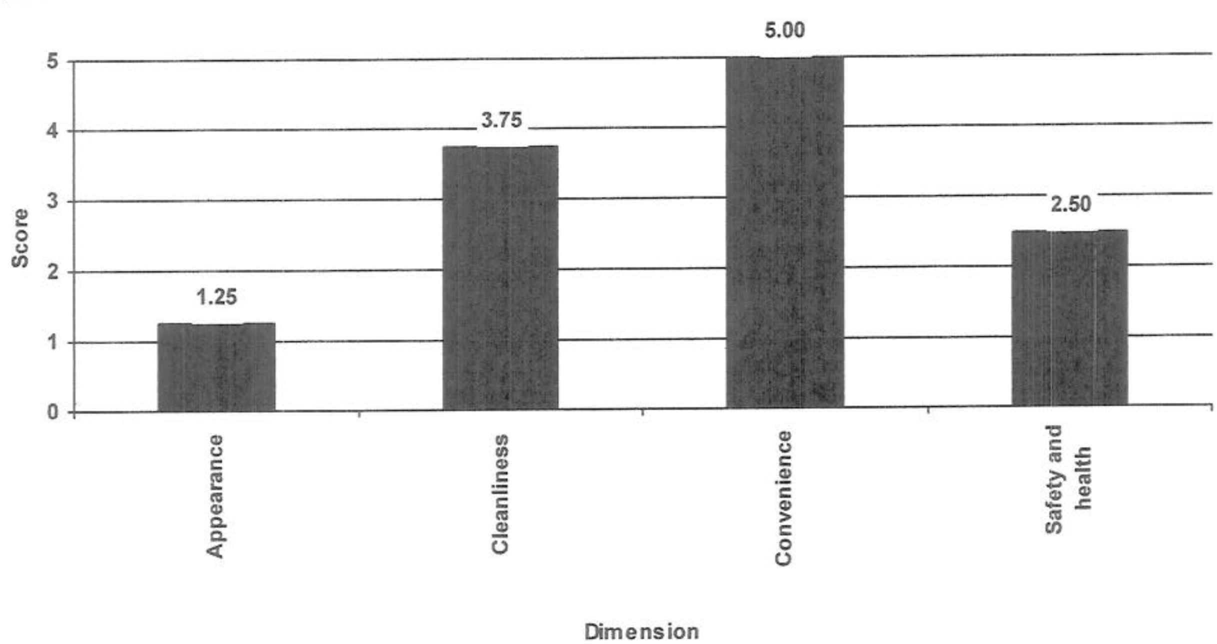
Hot water

Heating water for any purpose, e.g. beverages, dishes, personal, clothes washing.



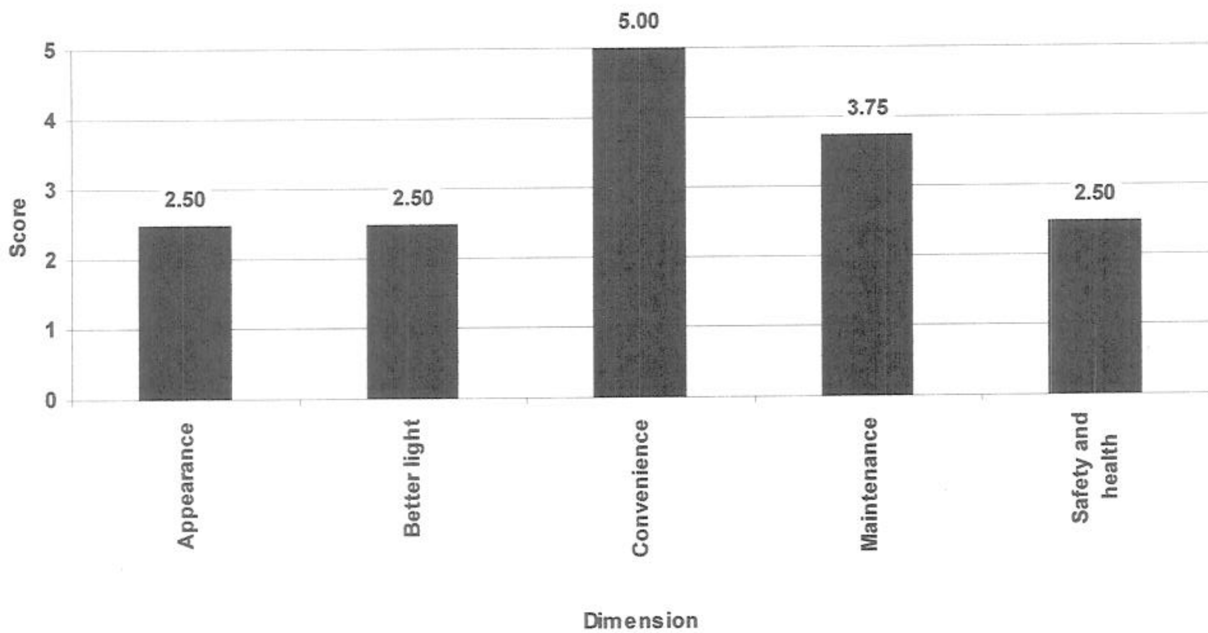
Ironing

Heating an iron (any type of iron)



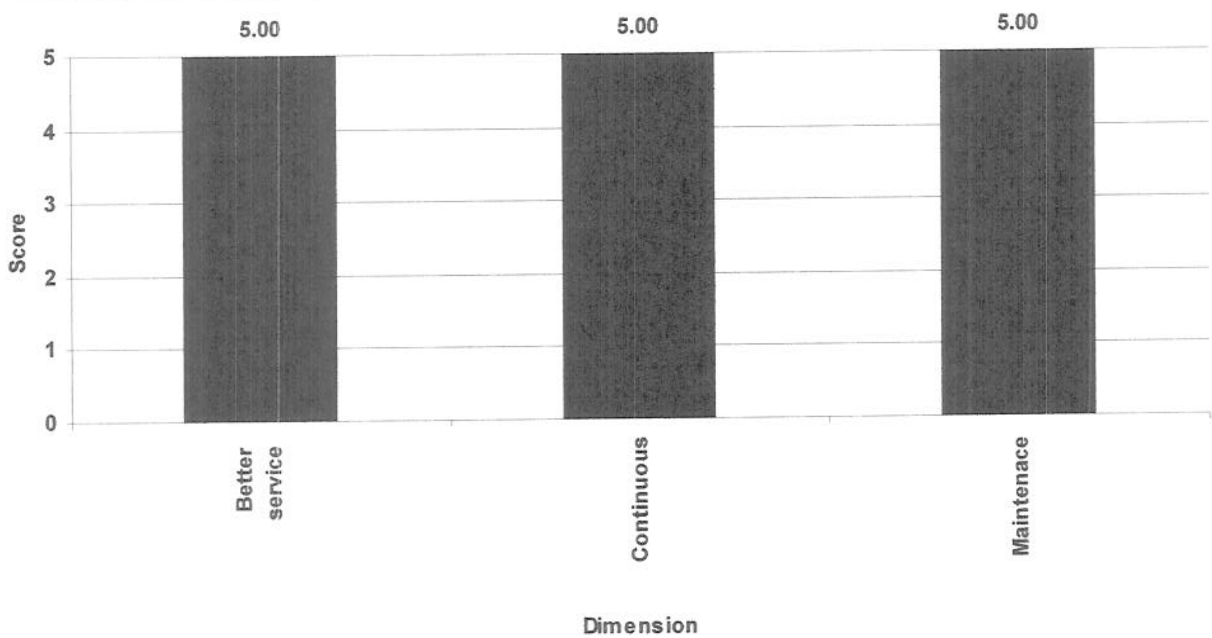
Analysis	Okuryangava Study (OK and ON)	**Demographic**	Low Income Demog
Scenario	Low Income & fridge	**Basket**	Low #6

Lighting



Media & Other Services

Supply of Electricity for any household appliance, not listed services, e.g. cooking.



Appendix G.6.5: “Medium Income Demog” & “Medium Income”: Comparing baskets

Basket contents and access cost

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Basket Med #1

No.	Appliance	Unit cost	Total cost	
1 off Available ✓	Low Power radio Plugs into the Pv type 12Volt system	90.00 ea	90.00 total	ZAR
1 off Available ✓	Gas refrigerator (100l) Medium refrigerator	4,227.00 ea	4,227.00 total	ZAR
1 off Available ✓	Solar stove Uses parabolic mirrors to provide concentrated 200 to 400 degrees Celsius heat	600.00 ea	600.00 total	ZAR
1 off Available ✓	Gas low pressure stove - single	40.00 ea	40.00 total	ZAR
3 off Available ✓	Low power electric light 12 W CFL High efficiency bulb	0.00 ea	0.00 total	ZAR
1 off Available ✓	Low-power electric television For use with a low-power electricity supply, not batteries	314.00 ea	314.00 total	ZAR

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Total cost of Appliances **5,271.00** **ZAR**

Fuel	Fuel access cost	
Solar PV 150	6,000.00	ZAR
LPG	299.71	ZAR
Sun	0.00	ZAR

Total Fuel access cost **6,299.71** **ZAR**

Total Basket access cost **11,570.71** **ZAR**

Analysis	Okuryangava Study (OK and ON)	Demographic	Medium Income Demog
Scenario	Medium Income		

Basket Med #2

No.	Appliance	Unit cost	Total cost	
1 off Available ☑	Gas low pressure stove - double	240.00 ea	240.00 total	ZAR
1 off Available ☑	Solar stove Uses parabolic mirrors to provide concentrated 200 to 400 degrees Celsius heat	600.00 ea	600.00 total	ZAR
1 off Available ☑	Gas refrigerator (100l) Medium refrigerator	4,227.00 ea	4,227.00 total	ZAR
1 off Available ☑	Low Power radio Plugs into the Pv type 12Volt system	90.00 ea	90.00 total	ZAR
1 off Available ☑	Low-power electric television For use with a low-power electricity supply, not batteries	314.00 ea	314.00 total	ZAR
5 off Available ☑	Low power electric light 12 W CFL High efficiency bulb	0.00 ea	0.00 total	ZAR

Analysis	Okuryangava Study (OK and ON)	Demographic	Medium Income Demog
Scenario	Medium Income		

Basket Med #3

No.	Appliance	Unit cost	Total cost	
1 off Available ☑	High power electric radio	170.00 ea	170.00 total	ZAR
5 off Available ☑	Low power electric light 12 W CFL High efficiency bulb	0.00 ea	0.00 total	ZAR
1 off Available ☑	Gas low pressure stove - double	240.00 ea	240.00 total	ZAR
1 off Available ☑	Solar stove Uses parabolic mirrors to provide concentrated 200 to 400 degrees Celsius heat	600.00 ea	600.00 total	ZAR
1 off Available ☑	High power electric freezer (70l)	1,300.00 ea	1,300.00 total	ZAR
1 off Available ☑	High power electric television	1,379.00 ea	1,379.00 total	ZAR

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Total cost of Appliances **3,689.00** **ZAR**

Fuel	Fuel access cost	
Solar PV 300	29,700.00	ZAR
LPG	299.71	ZAR
Sun	0.00	ZAR
PE 2.5 amp	500.00	ZAR

Total Fuel access cost **30,499.71** **ZAR**

Total Basket access cost **34,188.71** **ZAR**

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Basket Med #4

No.	Appliance	Unit cost	Total cost	
2 off Available ✓	Gas low pressure stove - single	40.00 ea	80.00 total	ZAR
1 off Available ✓	Solar stove Uses parabolic mirrors to provide concentrated 200 to 400 degrees Celsius heat	600.00 ea	600.00 total	ZAR
1 off Available ✓	High power electric freezer (70l)	1,300.00 ea	1,300.00 total	ZAR
1 off Available ✓	High power electric television	1,379.00 ea	1,379.00 total	ZAR
1 off Available ✓	High power electric radio	170.00 ea	170.00 total	ZAR
5 off Available ✓	High power electric light 60W incandescent Standard bulb	54.00 ea	270.00 total	ZAR

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Total cost of Appliances	**3,799.00**	**ZAR**

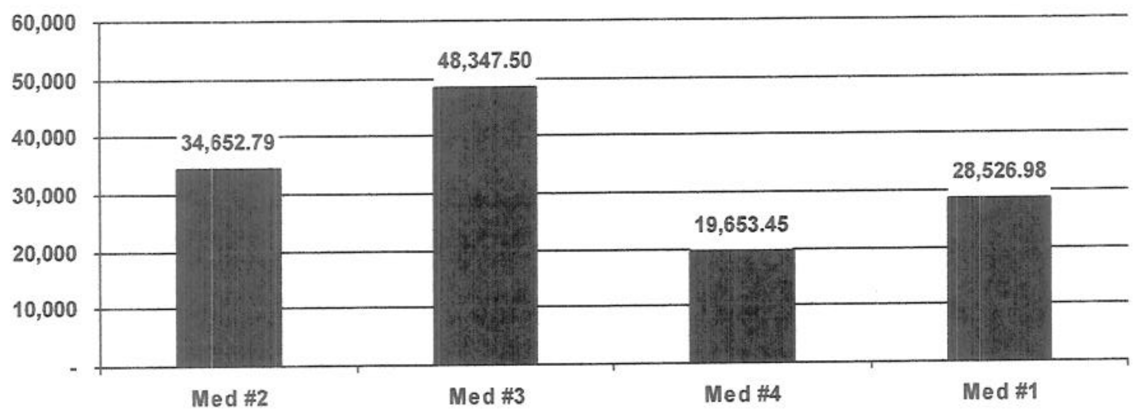
Fuel	Fuel access cost	
LPG	299.71	ZAR
Sun	0.00	ZAR
PE 2.5 amp	500.00	ZAR
Total Fuel access cost	**799.71**	**ZAR**

Total Basket access cost	**4,598.71**	**ZAR**

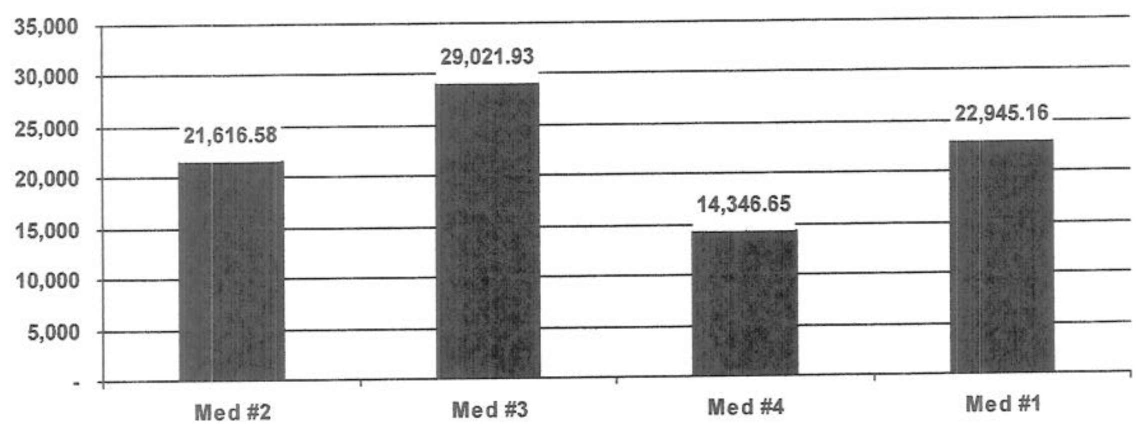
Life-cycle costs

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Life cycle costs based on local survey data



Life cycle costs based on EnPower estimates



Comparison period 10.0 **years** **Annual discount rate** 15% **All costs in** ZAR

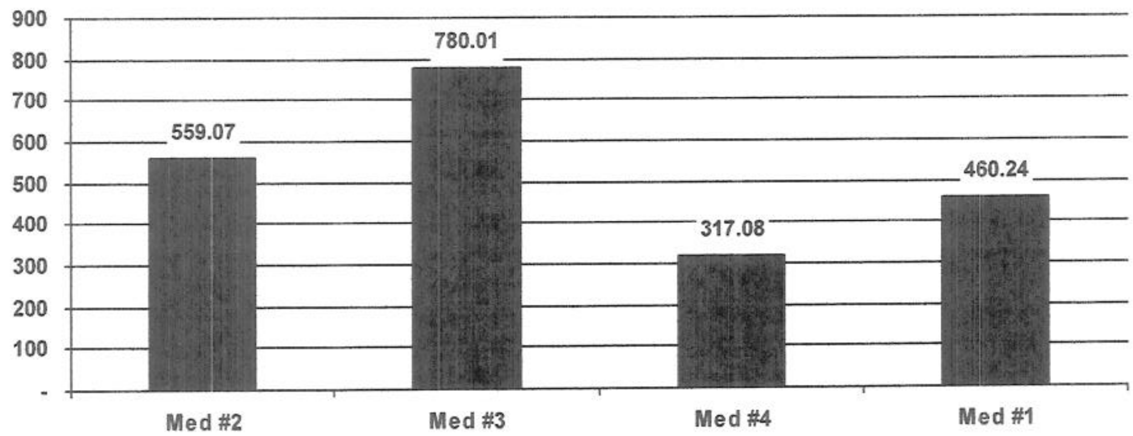
NOTES

Life cycle costs are used to show how much something costs over a defined period. For example an Appliance that is cheap to buy but expensive to run may cost more in the long-term than a more expensive device that is cheaper to run. Life cycle costs are based on a comparison period and a discount rate. See the EnPower guidance for more explanation. Lower life cycle costs mean lower expenditure over the long-term.

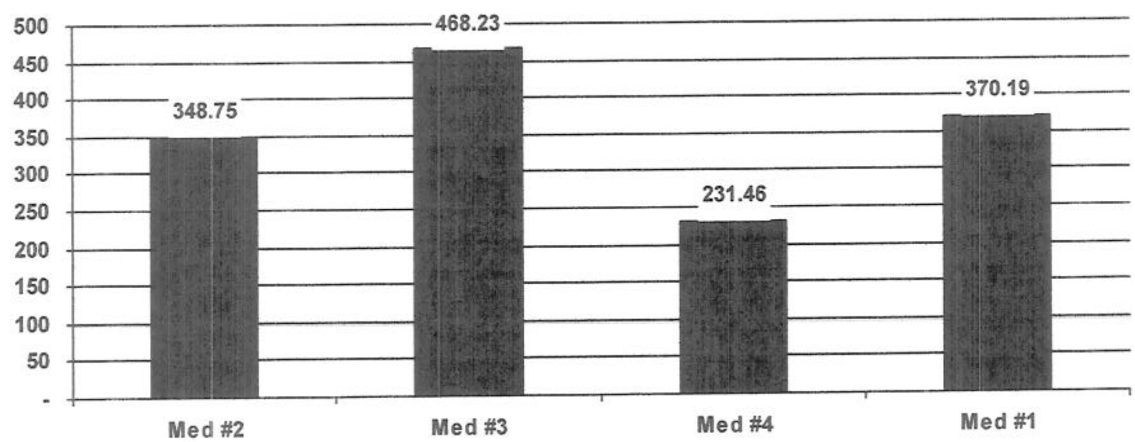
Average monthly expenditure

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Average monthly payments based on local survey data



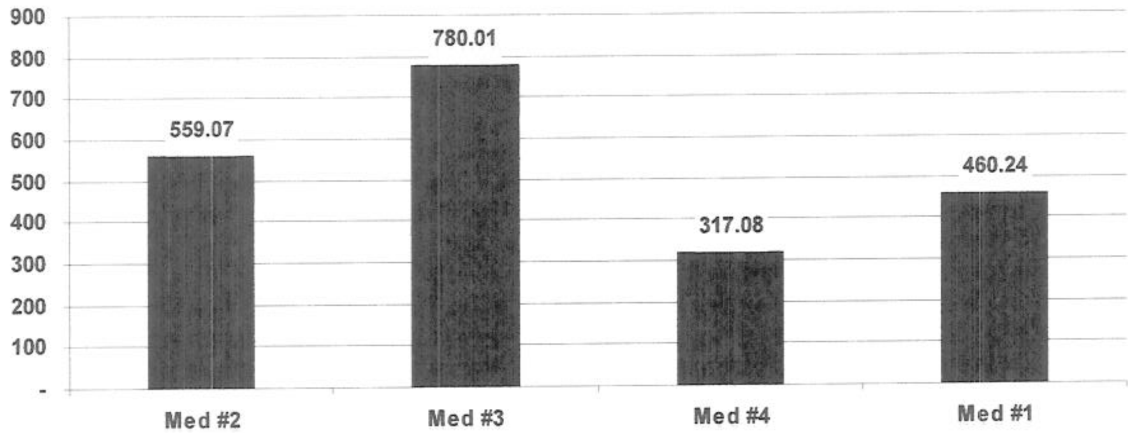
Average monthly payments based on EnPower estimates



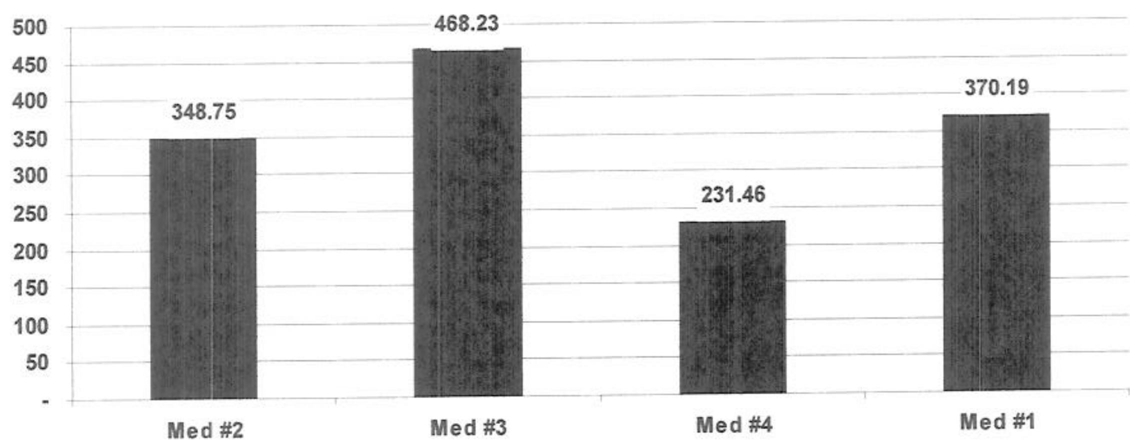
Comparison period 10.0 **years** **Annual discount rate** 15% **All costs in** ZAR

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Average monthly payments based on local survey data



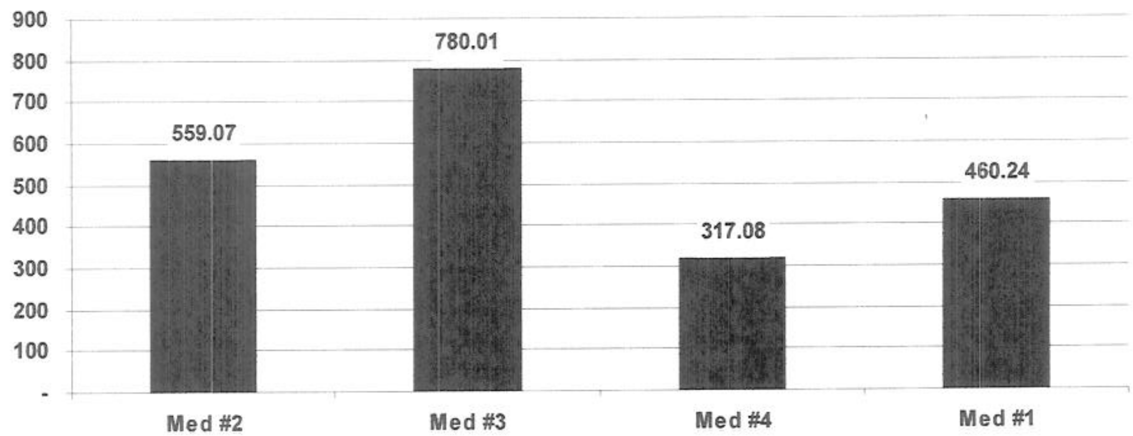
Average monthly payments based on EnPower estimates



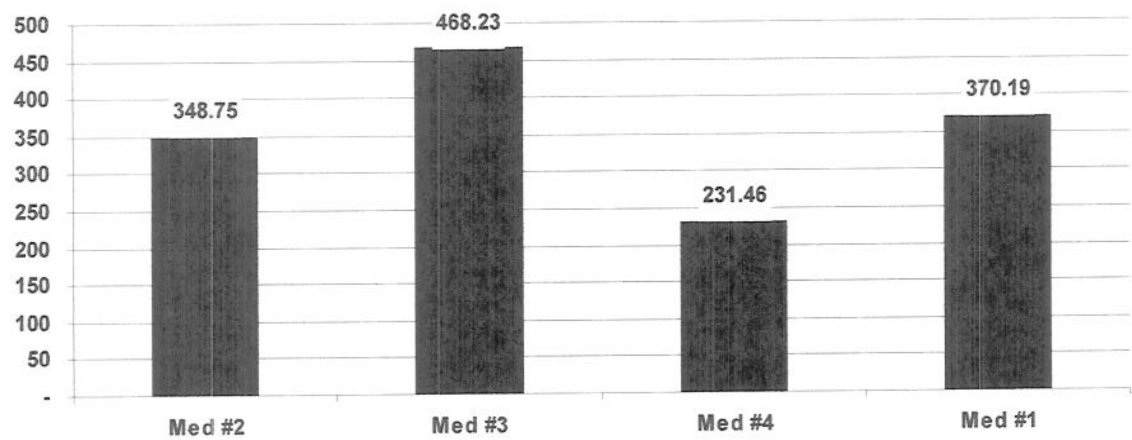
Comparison period 10.0 **years** **Annual discount rate** 15% **All costs in** ZAR

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Average monthly payments based on local survey data



Average monthly payments based on EnPower estimates



Comparison period 10.0 **years** **Annual discount rate** 15% **All costs in** ZAR

NOTES

The monthly costs are calculated from the Present Value of the basket. The Present Value is calculated from the Discount Rate and the Amortisation Period.

This represents the amount of money the Customer would need to spend to buy and run the Basket for all their specified needs. It takes account of the need of the Customer to borrow money and repay it over the Amortisation period at a rate equivalent to the Discount Rate.

This therefore represents the real running costs to the Customer on a consistent and comparable basis in todays money.

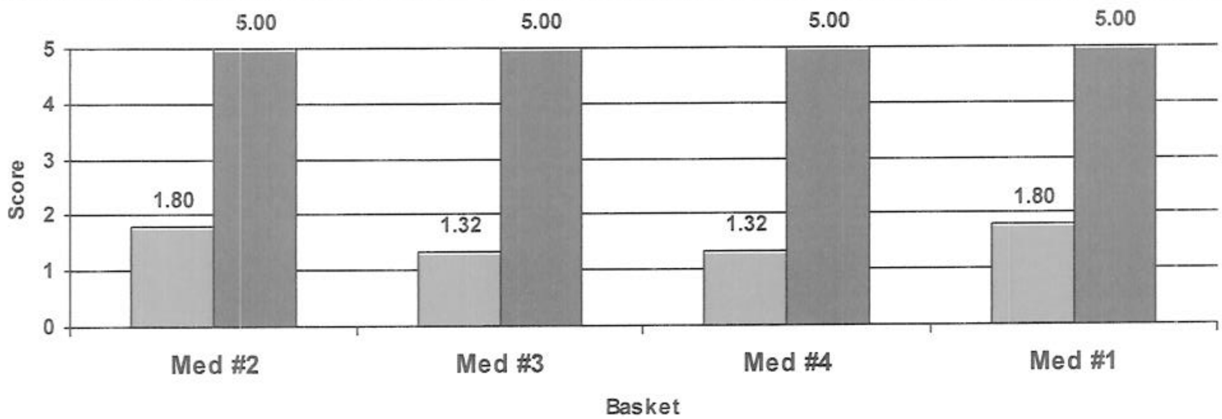
Performance scores

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Quantity Score
Rating score

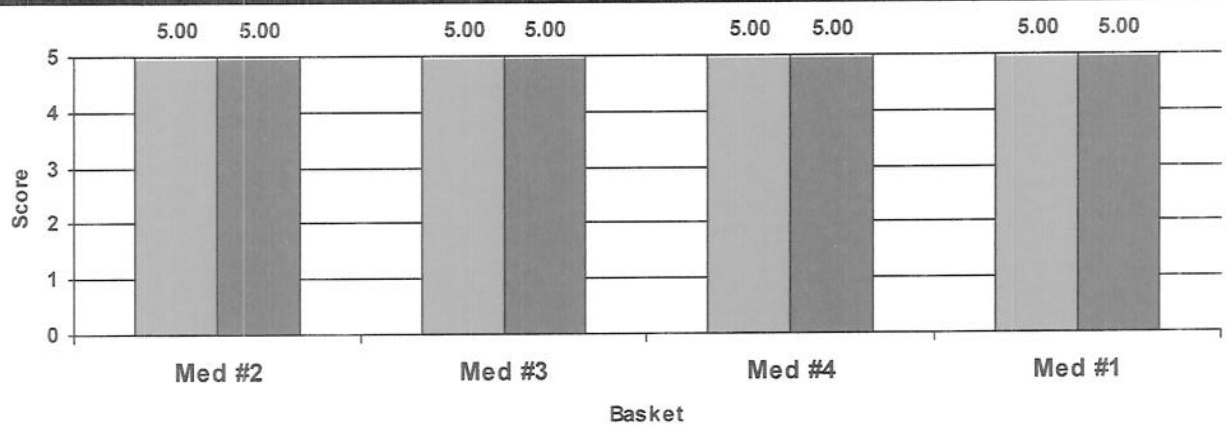
Hot water

Heating water for any purpose, e.g. beverages, dishes, personal, clothes washing.



Ironing

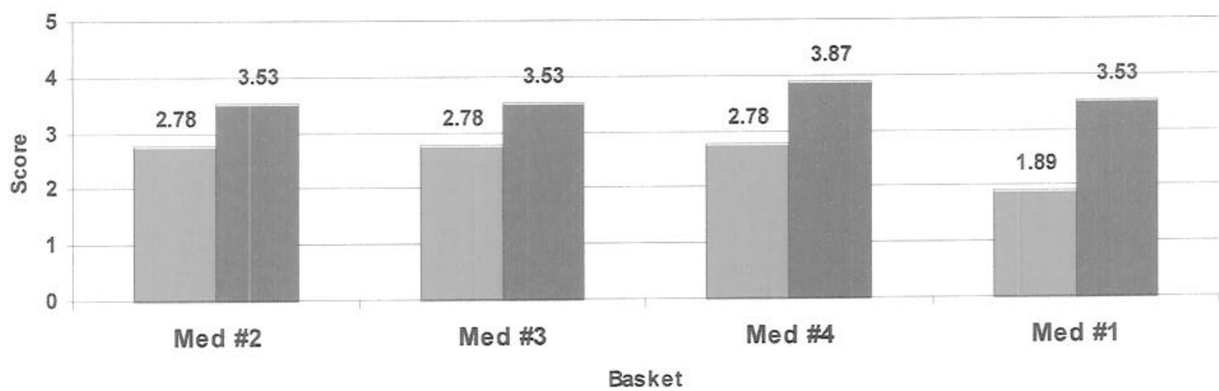
Heating an iron (any type of iron)



Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

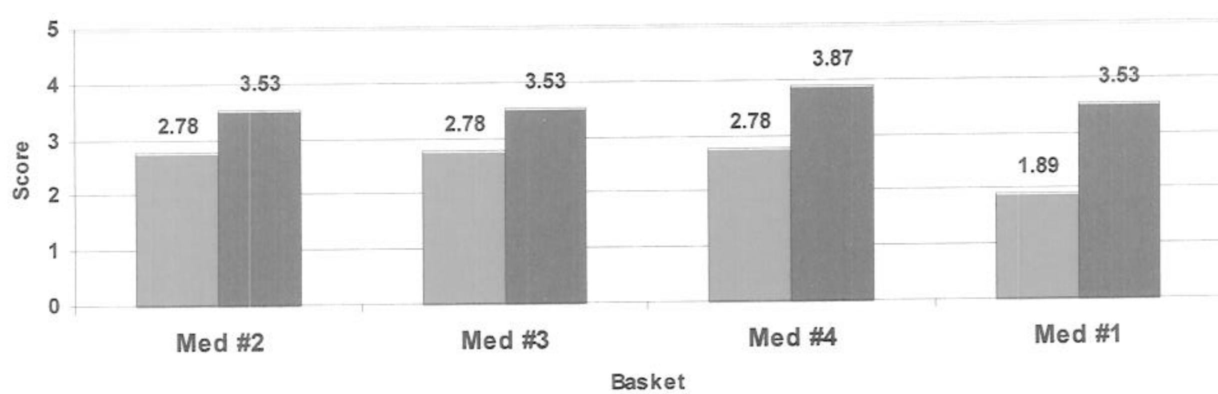
Quantity Score
Rating score

Lighting



Media & Other Services

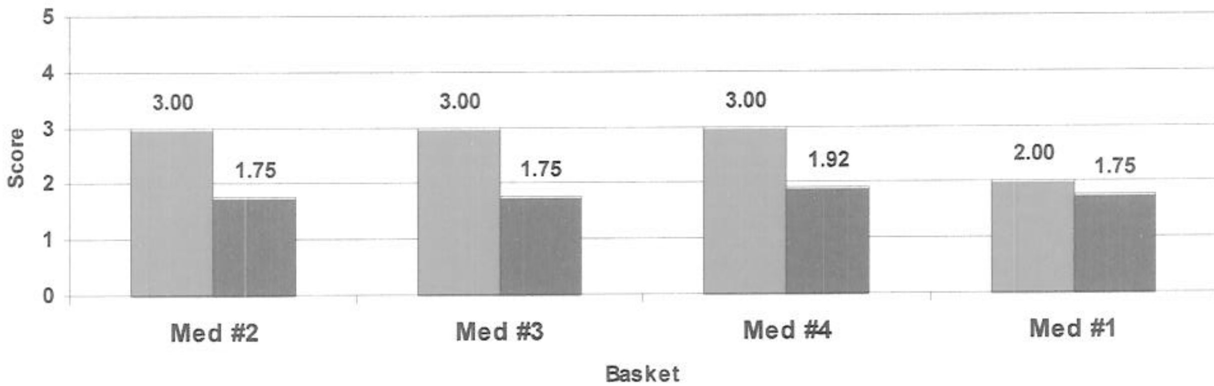
Supply of Electricity for any household appliance, not listed services, e.g. cooking.



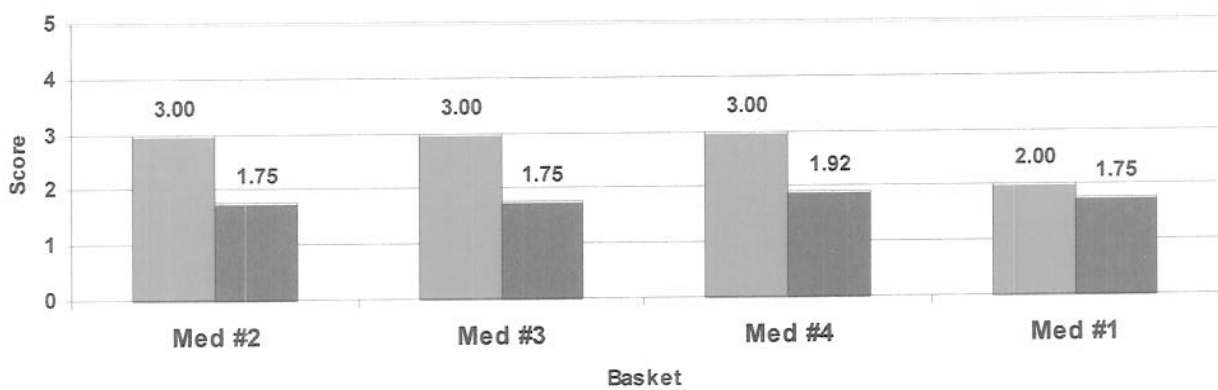
Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Quantity Score
Rating score

Plate cooking Cooking with pots and pans, not grilling or baking



Refrigeration Refrigeration for cooling and storing perishable foodstuff



Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Quantity Score
Rating score

This Report compares different Baskets in terms of their Performance. All of the Baskets shown here provide at least the minimum level of Service. If the Basket meets the mimimum requirement for a Service it gets a Score of 1. If the Basket meets the Maximum requirement the Basket it Scores 5. If the Basket lies somewhere between the minimum and maximum requirement then it Scores somewhere between 1 and 5. The Score depends on the Performance of each Appliance in the Basket that can provide that Service. If the Basket exceeds the maximum requirement it still only Scores a maximum of 5 points.

If a Basket is shown on this form then it is suitable for the Household and will meet their needs. The basket with the highest overall Score is the best Basket in terms of its Performance. The Performance of the Basket must be balanced against its cost, the Householders' Preferences, Environmental Performance etc. See the EnPower Guidance for more information.

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Present Fuel use and cost breakdown

Fuel type	Fuel	Fuel Use [/month]			Unit cost		Fuel Cost [/month]		
		Survey	Calc.	Units			Survey	Calc.	
Candles		0.53	0.52	kg	13.89	ZAR/kg	7.39	7.26	ZAR
Dry Cell Battery		38.42	37.44	Vah	0.45	ZAR/Vah	17.29	16.85	ZAR
Low Power Elec	3rd Party charging	221.54	229.29	Vah	0.33	ZAR/Vah	73.11	75.67	ZAR
Low Power Elec	Solar PV 100	221.54	229.29	Vah	0.01	ZAR/Vah	1.11	1.15	ZAR
Low Power Elec	Solar PV 150	221.54	229.29	Vah	0.01	ZAR/Vah	1.11	1.15	ZAR
Low Power Elec	Solar PV 300	221.54	229.29	Vah	0.01	ZAR/Vah	1.11	1.15	ZAR
LPG		4.77	5.29	kg	10.00	ZAR/kg	47.69	52.85	ZAR
Paraffin		16.77	16.56	l	5.00	ZAR/l	83.85	82.80	ZAR
Wood		49.80	46.48	kg	1.13	ZAR/kg	56.28	52.52	ZAR

Survey means values estimated by Householders based on their present monthly Fuel purchases.
Calc. means values estimated based on the Appliances and Services presently used by the Housholders.

Present Fuel cost estimate (takes information from the table above)

Fuel type	Surveyed [/month]	Calculated [/month]	
Candles	7.39	7.26	ZAR
Dry Cell Battery	17.29	16.85	ZAR
Low Power Elec	1.11 - 73.11	1.15 - 75.67	ZAR
LPG	47.69	52.85	ZAR
Paraffin	83.85	82.80	ZAR
Wood	56.28	52.52	ZAR
Monthly fuel expenditure estimates	213.60 - 285.60	213.43 - 287.95	ZAR

Survey means values estimated by Householders based on their present monthly Fuel purchases.
Calc. means values estimated based on the Appliances and Services used presently by the Housholders.

This report lists the Fuels that are currently used by the Community. This information comes from two different places. The Householders were asked how much Fuel they used each month. This is the 'Surveyed' amount. The householders were also asked what Appliances they used to supply which Services and how much they used them. From this the 'Calculated' Fuel use can be estimated by EnPower.

The top table shows the Fuels that are used, how much they are used and how much they cost. For some Fuel Types we cannot be sure which specific Fuel is used. For example, if the Household uses Low Power electricity then we cannot be sure whether they use Dry Cell Batteries or Lead Acid Batteries for example. All the different options are shown in the top table.

The bottom table takes information from the top table. This table shows the range of Fuel Expenditure by each average Household on each type of Fuel.

Importance of preference dimensions

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Hot water

	Dimension	Importance
1	Better Service	38%
2	Capacity	38%
3	Convenient	13%
4	Safety and health	13%

Ironing

	Dimension	Importance
1	Convenience	40%
2	Cleanliness	30%
3	Safety and health	20%
4	Appearance	10%

Lighting

	Dimension	Importance
1	Convenience	31%
2	Maintenance	23%
3	Appearance	15%
4	Better light	15%
5	Safety and health	15%

Media & Other Services

	Dimension	Importance
1	Better service	33%
2	Continuous	33%
3	Maintenace	33%

Plate cooking

	Dimension	Importance
1	Maintenance	22%
2	Reliability	22%
3	Safety and health	22%
4	Convenience	17%
5	Better cooking	13%
6	Appearance	4%

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Refrigeration

	Dimension	Importance
1	Appearance	25%
2	Maintenance	25%
3	Reliability	25%
4	Safety and health	25%

This report lists the Dimensions the Services required by the Community. It shows the relative importance of the Dimensions based on the information provided by the Community. In each case the most important Dimensions are at the top of the list. This report does not however make any judgements on the relative importance of the different Services.

Basket environmental impact

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Basket Med #1

Fuel		Annual household emmissions [kg/year]		
		CO2	**SO2**	**NOx**
Low Power Elec	Solar PV 150	0 - 0	0 - 0	0 - 0
LPG		0 - 0	0 - 0	0 - 0
Solar-thermal	Sun	0 - 0	0 - 0	0 - 0
	Total	**0 - 0**	**0 - 0**	**0 - 0**

Basket Med #2

Fuel		Annual household emmissions [kg/year]		
		CO2	**SO2**	**NOx**
Low Power Elec	Solar PV 100	0 - 0	0 - 0	0 - 0
LPG		0 - 0	0 - 0	0 - 0
Solar-thermal	Sun	0 - 0	0 - 0	0 - 0
	Total	**0 - 0**	**0 - 0**	**0 - 0**

Basket Med #3

Fuel		Annual household emmissions [kg/year]		
		CO2	**SO2**	**NOx**
High power electricity	PE 2.5 amp	0 - 0	0 - 0	0 - 0
Low Power Elec	Solar PV 300	0 - 0	0 - 0	0 - 0
LPG		0 - 0	0 - 0	0 - 0
Solar-thermal	Sun	0 - 0	0 - 0	0 - 0
	Total	**0 - 0**	**0 - 0**	**0 - 0**

Basket Med #4

Fuel		Annual household emmissions [kg/year]		
		CO2	**SO2**	**NOx**
High power electricity	PE 2.5 amp	0 - 0	0 - 0	0 - 0
LPG		0 - 0	0 - 0	0 - 0
Solar-thermal	Sun	0 - 0	0 - 0	0 - 0
	Total	**0 - 0**	**0 - 0**	**0 - 0**

This report estimates the amount of emissions of carbon dioxide (CO2), sulphur dioxide (SO2) and nitrogen oxides (NOx) that would be resleased into the atmosphere by the users of these baskets. This gives an idea as to which basket has the highest environmental impact. High numbers mean a higher level of impact. This information may be interesting to Stakeholders who are concerned about the environment.

Scenario details (Part 1)

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Analysis name	Okuryangava Study		
Community	OK and ON		
Location	Okuryangava		
Region	Khomas Region		
Country	South Africa	**Currency**	South African Rand (ZAR)
Community description	Okahandja Park (OK) and Ongulumbashe (ON) are situated within Okuryangava, 15 minutes north of Windhoek. Okuryangava consists of 300-400 households. The occupants are peri-urban poor, where mostly the women work as domestic workers.		
Analysis comment	The Okuryangava village was selected and engaged through the EnPower process and analysed according to the EnPower research framework and algorthim. We three WPI students will be evaluating the process according to our developed criteria.		
Demographic name	Medium Income Demog		
Demograhpic description	This demographic covers the middle income earners within the village those earning more than R1100		
No. households	13		
Scenario name	Medium Income		
Scenario description	Set of baskets aimed at the medium income level within Okuryangava ie those earning > R1100 per month		
Comparison period	10 years		
Discount rate	15.00%		
Comment	Okuryangava: 15% is the suggested value from the manual		
DataSource	Imported from Data Collation Tool		

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Present Basket

Appliance

Candle Holder	Standard candle holder
Dry cell battery radio	
Gas lamp (LP 100 CP)	Low pressure
Gas low pressure stove - double	
Gas refrigerator (100l)	Medium refrigerator
Low power electric light 12 W CFL	High efficiency bulb
Low Power radio	Plugs into the Pv type 12Volt system
Low-power electric television	For use with a low-power electricity supply, not batteries
Paraffin lamp - regular	
Paraffin stove - wick double plate	
Paraffin wick stove - low cost single	
Wood fire (open)	Typical fire used for cooking

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Present Service Use

Appliance	Service	Yearly use		Pen.
Candle Holder	General lighting	971	light sources.hours/year	54%
Dry cell battery radio	Radio	1,460	N/A.hours/year	31%
Gas lamp (LP 100 CP)	General lighting	913	light sources.hours/year	8%
Gas low pressure stove - double	Warm washing water	868	litres.litres/year	23%
Gas low pressure stove - double	Medium heat	1,688	hot plates.hours/year	31%
Gas low pressure stove - double	Rapid heating or frying	294	hot plates.hours/year	31%
Gas low pressure stove - double	Boiling water any purpose	958	litres.litres/year	31%
Gas refrigerator (100l)	Refrigerating food	348,000	litres.hours/year	15%
Low power electric light 12 W CFL	General lighting	1,095	light sources.hours/year	8%
Low Power radio	Radio	1,460	N/A.hours/year	38%
Low-power electric television	Television	760	N/A.hours/year	23%
Paraffin lamp - regular	General lighting	2,279	light sources.hours/year	54%
Paraffin stove - wick double plate	Boiling water any purpose	1,112	litres.litres/year	46%
Paraffin stove - wick double plate	Medium heat	1,764	hot plates.hours/year	46%
Paraffin stove - wick double plate	Warm washing water	1,582	litres.litres/year	23%
Paraffin stove - wick double plate	Ironing	52	irons.hours/year	8%
Paraffin wick stove - low cost single	Rapid heating or frying	630	hot plates.hours/year	15%
Paraffin wick stove - low cost single	Medium heat	1,643	hot plates.hours/year	8%
Paraffin wick stove - low cost single	Warm washing water	730	litres.litres/year	8%
Paraffin wick stove - low cost single	Boiling water any purpose	730	litres.litres/year	8%
Paraffin wick stove - low cost single	Ironing	52	irons.hours/year	8%
Wood fire (open)	Baking food	52	litres.hours/year	8%
Wood fire (open)	Boiling water any purpose	639	litres.litres/year	15%
Wood fire (open)	Medium heat	1,278	hot plates.hours/year	31%
Wood fire (open)	Ironing	80	irons.hours/year	54%
Wood fire (open)	Warm washing water	883	litres.litres/year	23%

Analysis	Okuryangava Study (OK and ON)	Demographic	Medium Income Demog
Scenario	Medium Income		

Present Fuel Use Check

Fuel	Surveyed	Calculated	Units	Difference
Candles	0.532	0.523	kg/day	-2%
Dry Cell Battery	38.423	37.436	Vah/day	-3%
Low Power Elec	221.538	229.295	Vah/day	3%
LPG	4.769	5.285	kg/day	10%
Paraffin	16.769	16.559	l/day	-1%
Wood	49.805	46.479	kg/day	-7%

Scenario details (Part 2)

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Service Requirements

Service type	Min	Max		Min	Max	
Hot water	1	1	litres	1	1	N/A
Ironing	1	3	irons	1	1	N/A
Lighting	1	10	light sources	45	1000	lumen @ 1m
Media & Other Services	1	1	N/A	1	1	N/A
Plate cooking	1	5	hot plates	0.2	5	total kW heat output
Refrigeration	50	300	litres	1	1	N/A

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Service Usage (Required Services only)

	Service	Quantity		Use	
Hot water	Boiling water any purpose	1	litres	3.25	litres/day
Hot water	Warm washing water	1	litres	7	litres/day
Ironing	Ironing	1	irons	1	hours/day
Lighting	General lighting	5	light sources	2.3	hours/day
Media & Other Services	Radio	1	N/A	4	hours/day
Media & Other Services	Television	1	N/A	2	hours/day
Plate cooking	Medium heat	2	hot plates	2.75	hours/day
Refrigeration	Refrigerating food	100	litres	24	hours/day

Scenario summary

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income		

Analysis name	Okuryangava Study
Community	OK and ON
Location	Okuryangava
Region	Khomas Region
Country	South Africa
Community description	Okahandja Park (OK) and Ongulumbashe (ON) are situated within Okuryangava, 15 minutes north of Windhoek. Okuryangava consists of 300-400 households. The occupants are peri-urban poor, where mostly the women work as domestic workers.
Analysis comment	The Okuryangava village was selected and engaged through the EnPower process and analysed according to the EnPower research framework and algorthim. We three WPI students will be evaluating the process according to our developed criteria.
Demographic name	Medium Income Demog
No. households	13
Scenario name	Medium Income
Demograhpic description	This demographic covers the middle income earners within the village those earning more than R1100
Scenario description	Set of baskets aimed at the medium income level within Okuryangava ie those earning > R1100 per month
Discount rate	15.00%
Comment	Okuryangava: 15% is the suggested value from the manual
Comparison period	10

Appendix G.6.6: "Medium Income Demog" & "Medium Income": Individual baskets

Important considerations about fuels

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #1

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation

Low Power Elec

3rd Party charging Poisoning	**M**	The lead in the batteries is toxic and there is a risk of poisoning. This is especially dangerous to children and pregnant women, can cause brain damage and metabolic disorders. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	Read the instructions and keep away from children.
3rd Party charging Pollution	**M**	If these batteries are not disposed of carefully they can cause polution. The lead can seep into waterways and damage drinking water and crops. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	Dispose of used batteries correctly.
3rd Party charging Storage & Shelf Life		Lead acid batteries do not last forever and need to be stored carefully and replaced when they no longer hold their charge. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	
Solar PV 100 Noise	**L**	Very small noise problem for some types. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	Site away from houses.

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #1

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Importance	Comment	Mitigation
Solar PV 100 Time to Collect		The wind is free and does not need to be collected. Time can be saved for the householder since they do not need to gather or shop for the fuel. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	
Solar PV 300 Limited current		Can only supply a limited current and cannot be used with high power devices - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	
Solar PV 300 Limited use		Limited amount of time can be used per day 4 hours of lighting and/or radio - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	
Solar PV 300 Not for cooking		It is not possible to use electric cookers with photovoltaic power - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	
Solar PV 300 Time to Collect		The sun is free and does not need to be collected. Time can be saved for the householder since they do not need to gather or shop for the fuel. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #1

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
LPG			
Fire	**M**	A low risk of fire occurring exists when this fuel is used. Gas appliances are generally quite safe. - Gas low pressure stove - single - Gas refrigerator (100l)	
Poisoning	**L**	Poisonous carbon monoxide can be released if the equipment is not serviced properly - Gas low pressure stove - single - Gas refrigerator (100l)	
Storage and shelf life	**M**	The gas is supplied in bulky containers that must be regularly serviced and not overfilled. Transporting the gas in some of the larger bottles without a vehicle can be difficult. - Gas low pressure stove - single - Gas refrigerator (100l)	
Suffocation	**L**	Suffocation is a very low risk but this can become serious if appliances are not serviced and they are not stored in a well ventilated area. - Gas low pressure stove - single - Gas refrigerator (100l)	
Waste disposal	**L**	The containers for LPG can be reused - Gas low pressure stove - single - Gas refrigerator (100l)	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #1

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import- ance	Comment	Mitigation

Solar-thermal

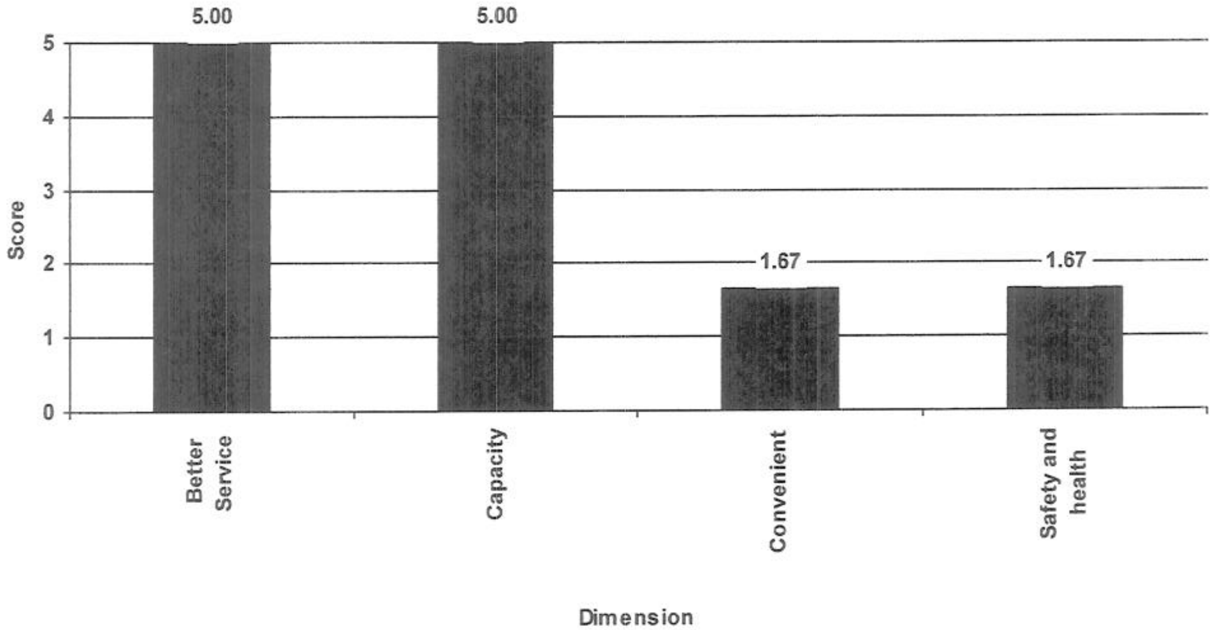
Sun Exit/Switching cost		There is not cost to start using sun power. - Solar stove	
Sun Pollution		Using solar power produces no pollution of any kind. - Solar stove	
Sun Quality of Life		Solar power does not produce smoke or other unpleasant fumes. - Solar stove	

Preference scores

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #1

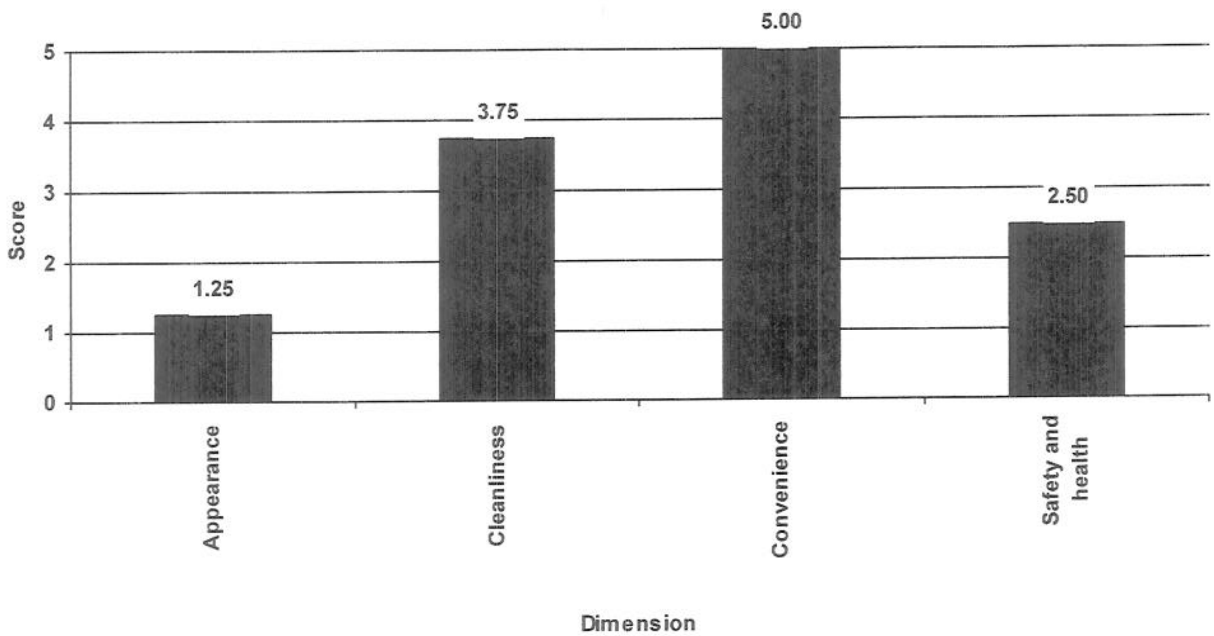
Hot water

Heating water for any purpose, e.g. beverages, dishes, personal, clothes washing.



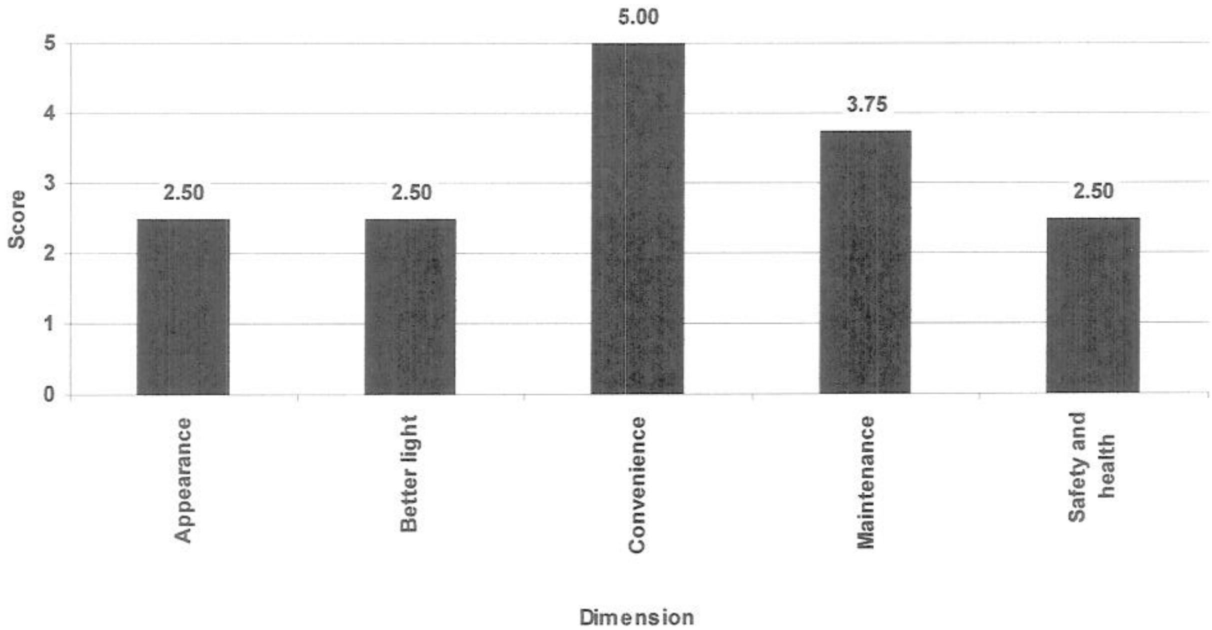
Ironing

Heating an iron (any type of iron)



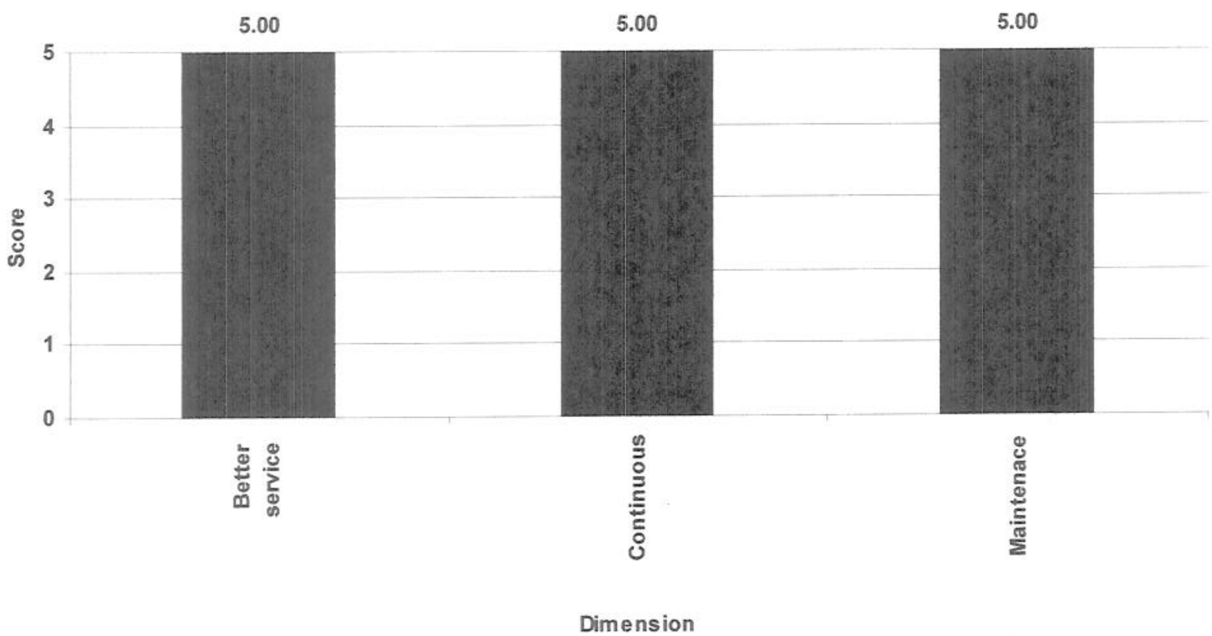
Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #1

Lighting



Media & Other Services

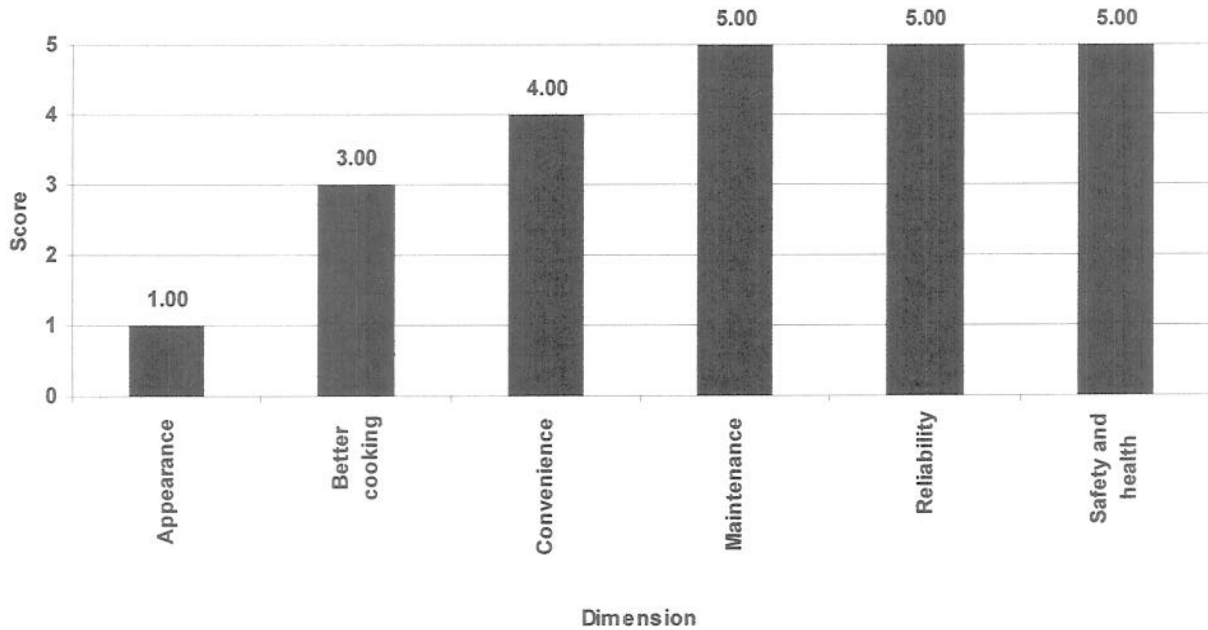
Supply of Electricity for any household appliance, not listed services, e.g. cooking.



Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #1

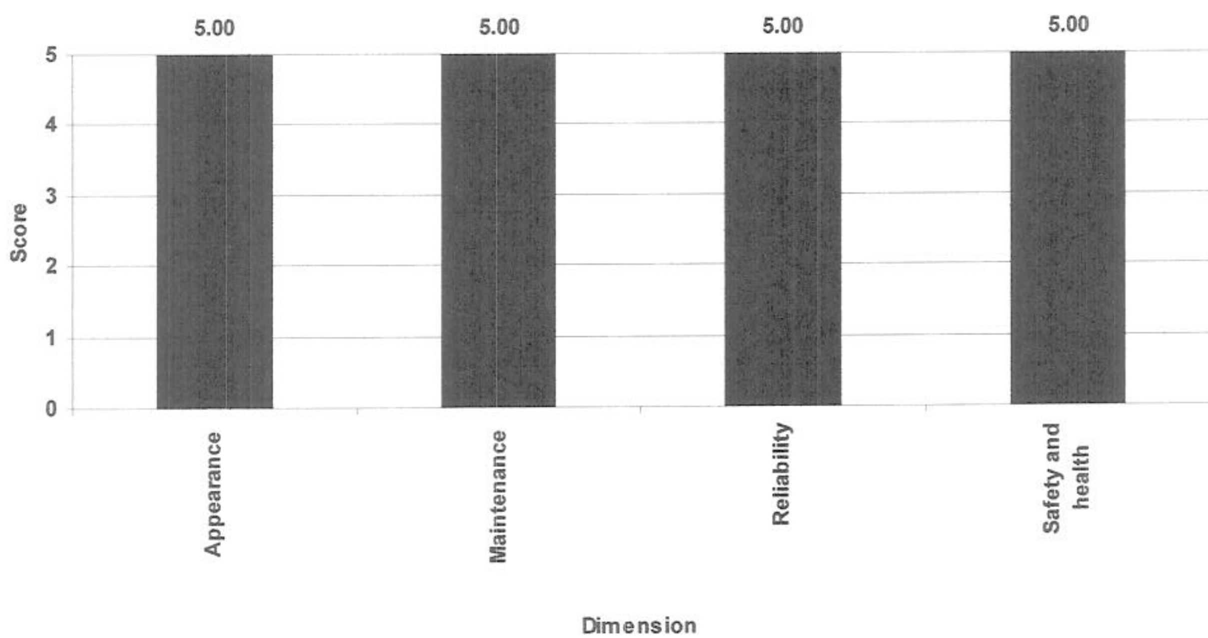
Plate cooking

Cooking with pots and pans, not grilling or baking



Refrigeration

Refrigeration for cooling and storing perishable foodstuff



This report shows the average Scores against each Dimension of each Service for the Basket. The Scores take into account the Importance of each Dimension. If the Basket uses more than one Fuel to supply a particular Service then the Scores are the average Score. The Scores are adjusted so that the highest Score for any Dimension is always 5.

Important considerations about fuels

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #2

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation

Low Power Elec

3rd Party charging Poisoning	**M**	The lead in the batteries is toxic and there is a risk of poisoning. This is especially dangerous to children and pregnant women, can cause brain damage and metabolic disorders. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	Read the instructions and keep away from children.
3rd Party charging Pollution	**M**	If these batteries are not disposed of carefully they can cause polution. The lead can seep into waterways and damage drinking water and crops. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	Dispose of used batteries correctly.
3rd Party charging Storage & Shelf Life		Lead acid batteries do not last forever and need to be stored carefully and replaced when they no longer hold their charge. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	
Solar PV 100 Noise	**L**	Very small noise problem for some types. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	Site away from houses.

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #2

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
Solar PV 100 Time to Collect		The wind is free and does not need to be collected. Time can be saved for the householder since they do not need to gather or shop for the fuel. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	
Solar PV 300 Limited current		Can only supply a limited current and cannot be used with high power devices - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	
Solar PV 300 Limited use		Limited amount of time can be used per day 4 hours of lighting and/or radio - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	
Solar PV 300 Not for cooking		It is not possible to use electric cookers with photovoltaic power - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	
Solar PV 300 Time to Collect		The sun is free and does not need to be collected. Time can be saved for the householder since they do not need to gather or shop for the fuel. - Low power electric light 12 W CFL - Low Power radio - Low-power electric television	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #2

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Importance	Comment	Mitigation
LPG			
Fire	**M**	A low risk of fire occurring exists when this fuel is used. Gas appliances are generally quite safe. - Gas low pressure stove - double - Gas refrigerator (100l)	
Poisoning	**L**	Poisonous carbon monoxide can be released if the equipment is not serviced properly - Gas low pressure stove - double - Gas refrigerator (100l)	
Storage and shelf life	**M**	The gas is supplied in bulky containers that must be regularly serviced and not overfilled. Transporting the gas in some of the larger bottles without a vehicle can be difficult. - Gas low pressure stove - double - Gas refrigerator (100l)	
Suffocation	**L**	Suffocation is a very low risk but this can become serious if appliances are not serviced and they are not stored in a well ventilated area. - Gas low pressure stove - double - Gas refrigerator (100l)	
Waste disposal	**L**	The containers for LPG can be reused - Gas low pressure stove - double - Gas refrigerator (100l)	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #2

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation

Solar-thermal

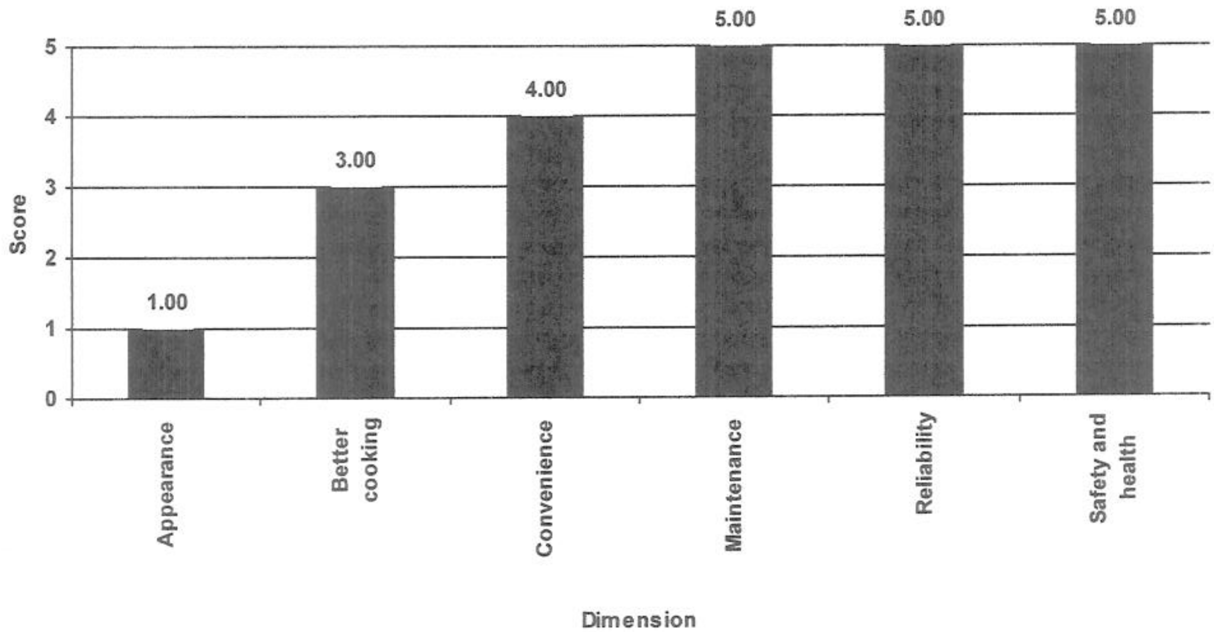
Fuel type Consideration / Device	Import-ance	Comment	Mitigation
Sun Exit/Switching cost		There is not cost to start using sun power. - Solar stove	
Sun Pollution		Using solar power produces no pollution of any kind. - Solar stove	
Sun Quality of Life		Solar power does not produce smoke or other unpleasant fumes. - Solar stove	

Preference scores

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #2

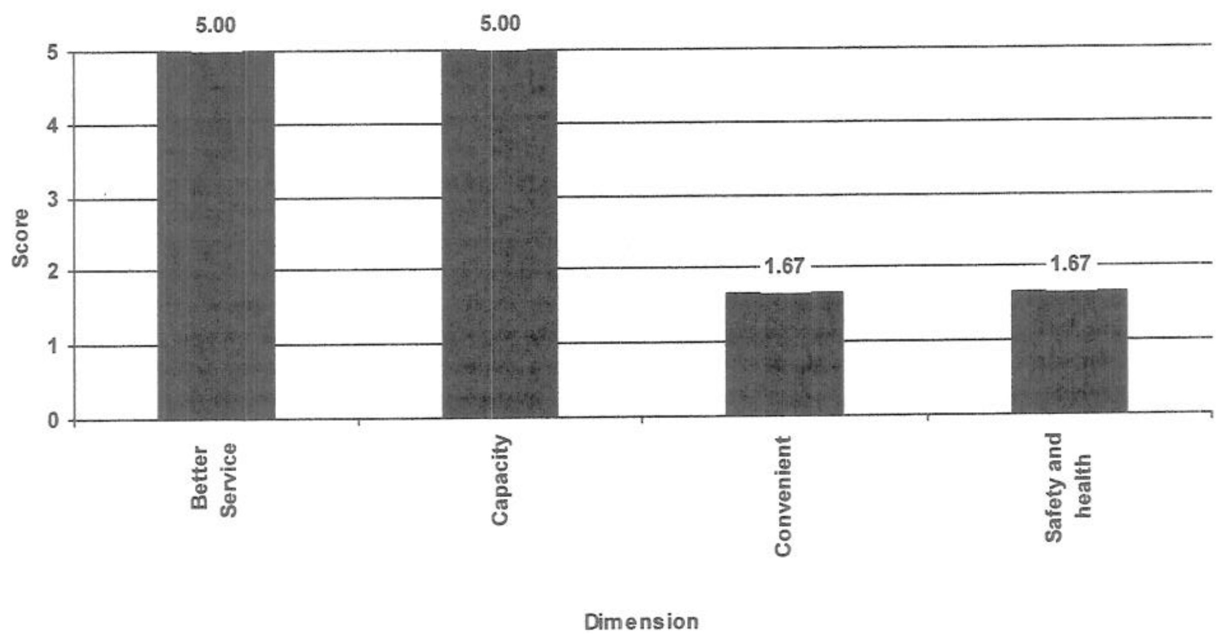
Hot water

Heating water for any purpose, e.g. beverages, dishes, personal, clothes washing.



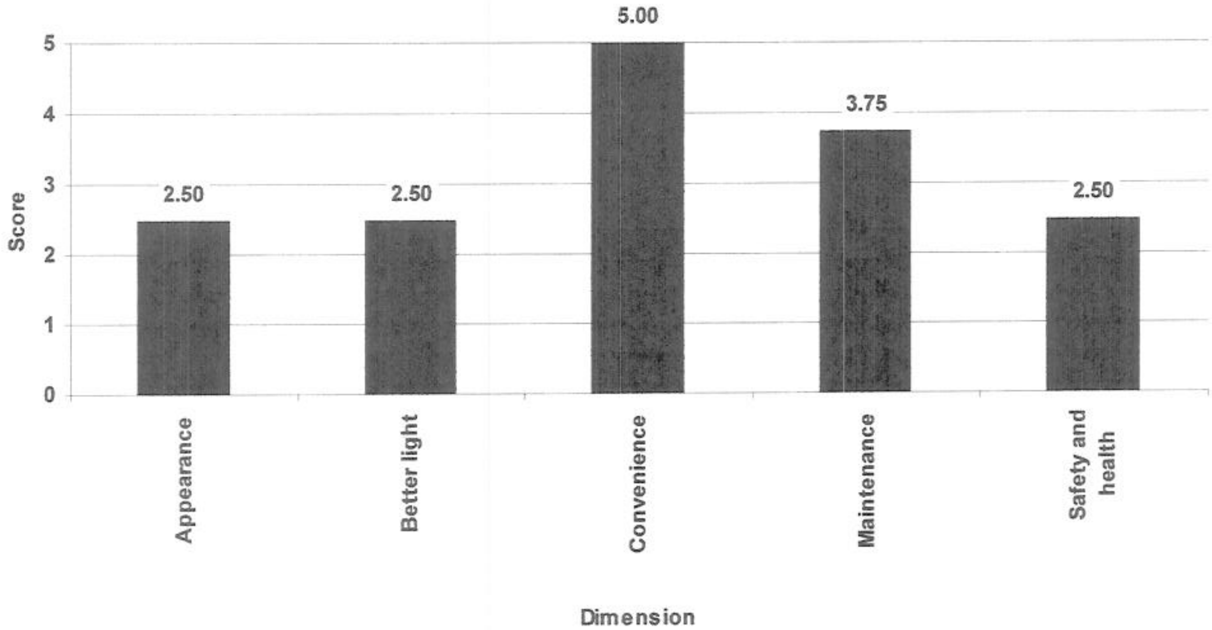
Ironing

Heating an iron (any type of iron)



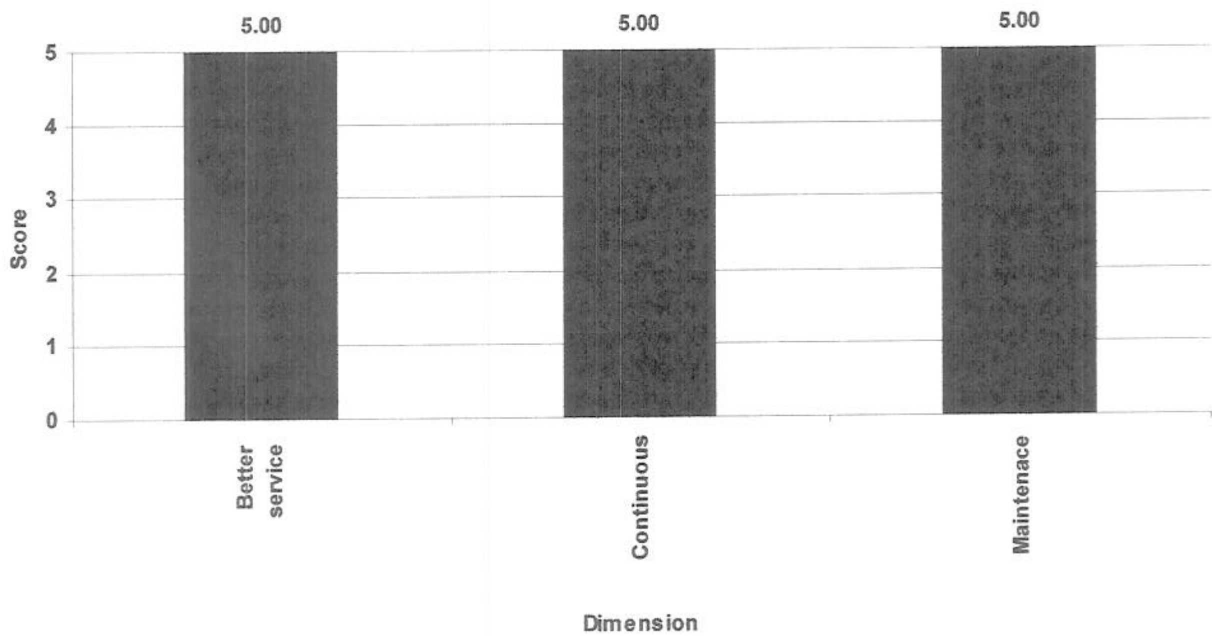
Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #2

Lighting



Media & Other Services

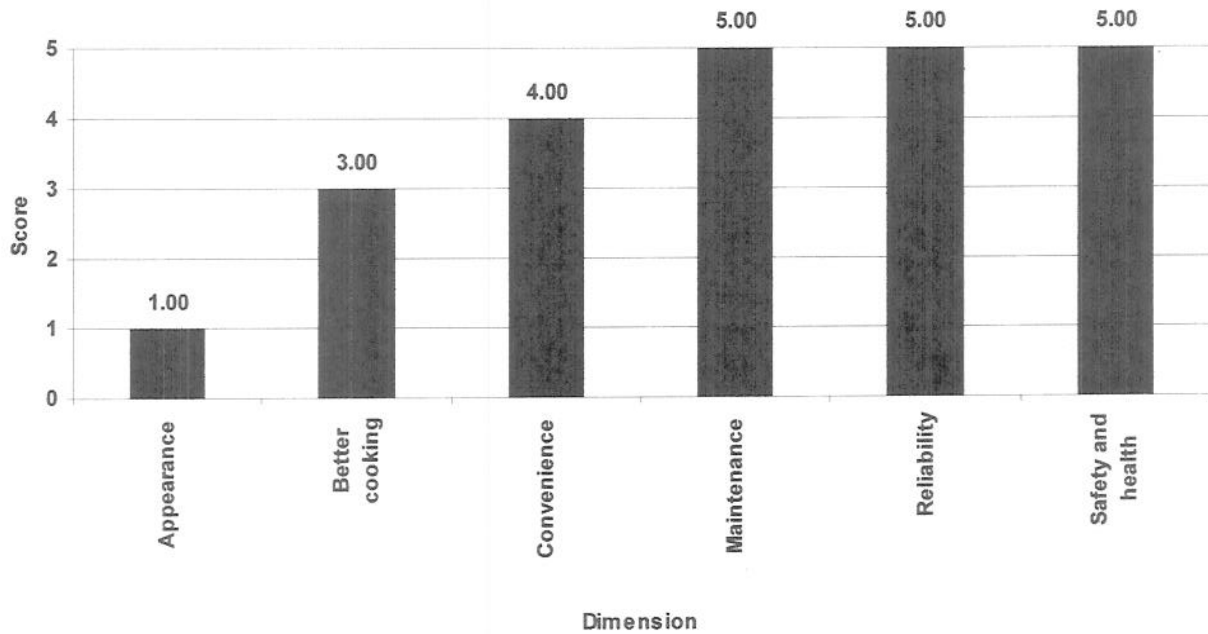
Supply of Electricity for any household appliance, not listed services, e.g. cooking.



Analysis	Okuryangava Study (OK and ON)	Demographic	Medium Income Demog
Scenario	Medium Income	Basket	Med #2

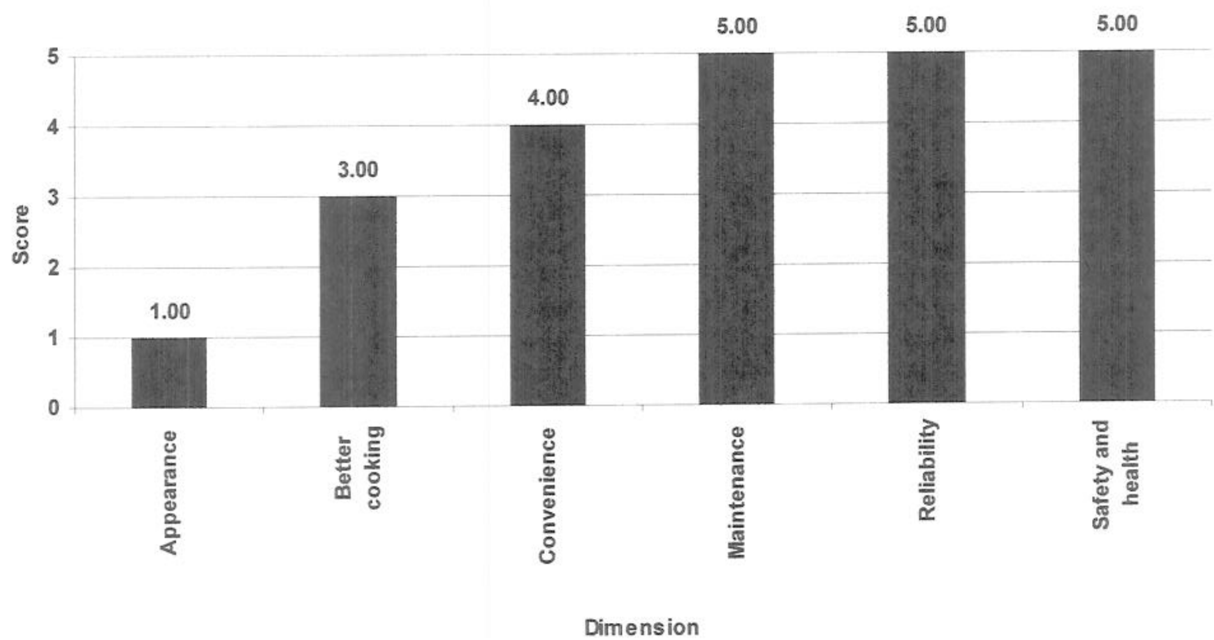
Plate cooking

Cooking with pots and pans, not grilling or baking



Refrigeration

Refrigeration for cooling and storing perishable foodstuff



This report shows the average Scores against each Dimension of each Service for the Basket. The Scores take into account the Importance of each Dimension. If the Basket uses more than one Fuel to supply a particular Service then the Scores are the average Score. The Scores are adjusted so that the highest Score for any Dimension is always 5.

Important considerations about fuels

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #3

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
High power electr			
Municipal Customer Electrocution	**L/M**	There is a risk of electrocution if guidelines are not followed or the electricity supplied is tampered with. - High power electric freezer (70l) - High power electric radio - High power electric television	Must be installed by approved persons.
Municipal Customer Exit/switching cost	**M**	There are usually connection fees, standing charges and usage charges associated with this type of electricity. Customers may need to sign a contract with the supplier. - High power electric freezer (70l) - High power electric radio - High power electric television	
PE Electrocution	**L/M**	There is a risk of electrocution if guidelines are not followed or the electricity supplied is tampered with. - High power electric freezer (70l) - High power electric radio - High power electric television	Must be installed by approved persons.
PE Exit/switching cost	**M**	There are usually connection fees, standing charges and usage charges associated with this type of electricity. Customers may need to sign a contract with the supplier. - High power electric freezer (70l) - High power electric radio - High power electric television	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #3

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import- ance	Comment	Mitigation
PE			
Quality of Life	H	Electricity can be used for many different types of appliance. - High power electric freezer (70l) - High power electric radio - High power electric television	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #3

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import-ance	Comment	Mitigation

Low Power Elec

Fuel type Consideration / Device	Import-ance	Comment	Mitigation
3rd Party charging Poisoning	M	The lead in the batteries is toxic and there is a risk of poisoning. This is especially dangerous to children and pregnant women, can cause brain damage and metabolic disorders. - Low power electric light 12 W CFL	Read the instructions and keep away from children.
3rd Party charging Pollution	M	If these batteries are not disposed of carefully they can cause polution. The lead can seep into waterways and damage drinking water and crops. - Low power electric light 12 W CFL	Dispose of used batteries correctly.
3rd Party charging Storage & Shelf Life		Lead acid batteries do not last forever and need to be stored carefully and replaced when they no longer hold their charge. - Low power electric light 12 W CFL	
Solar PV 100 Noise	L	Very small noise problem for some types. - Low power electric light 12 W CFL	Site away from houses.
Solar PV 100 Time to Collect		The wind is free and does not need to be collected. Time can be saved for the householder since they do not need to gather or shop for the fuel. - Low power electric light 12 W CFL	
Solar PV 300 Limited current		Can only supply a limited current and cannot be used with high power devices - Low power electric light 12 W CFL	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #3

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

Fuel type Consideration / Device	Import- ance	Comment	Mitigation
Solar PV 300 Limited use		Limited amount of time can be used per day 4 hours of lighting and/or radio - Low power electric light 12 W CFL	
Solar PV 300 Not for cooking		It is not possible to use electric cookers with photovoltaic power - Low power electric light 12 W CFL	
Solar PV 300 Time to Collect		The sun is free and does not need to be collected. Time can be saved for the householder since they do not need to gather or shop for the fuel. - Low power electric light 12 W CFL	

Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #3

Importance **H** = High
M = Medium
L = Low

Under each comment is a list of the Appliances to which the comment relates.

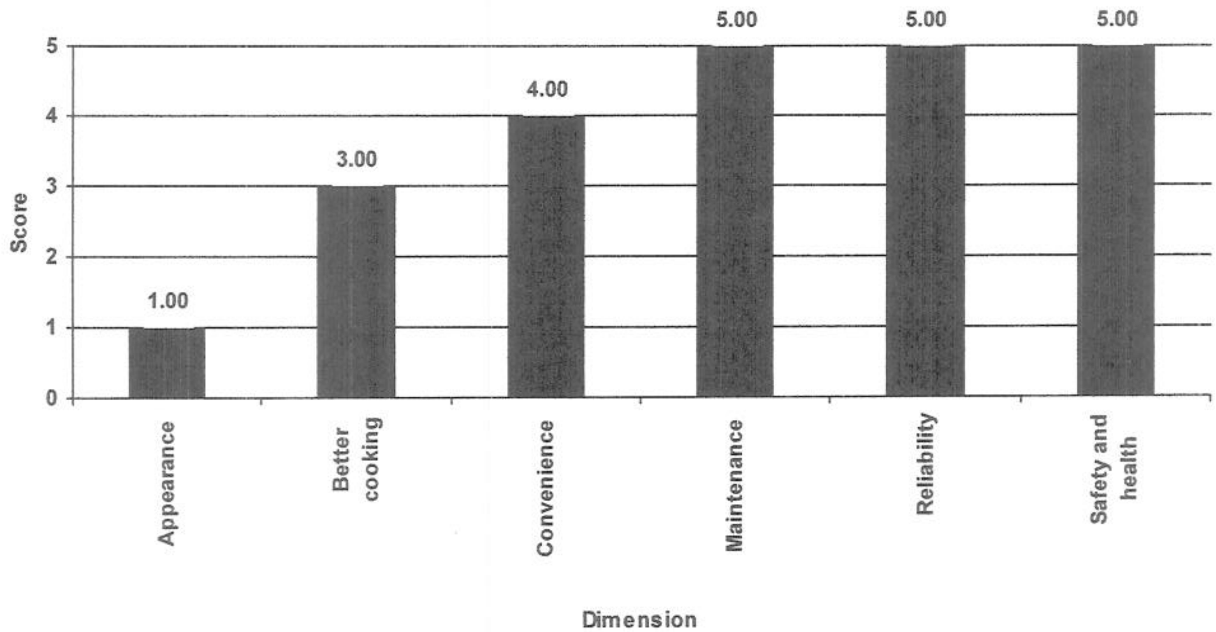
Fuel type Consideration / Device	Import-ance	Comment	Mitigation
Solar-thermal			
Sun Exit/Switching cost		There is not cost to start using sun power. - Solar stove	
Sun Pollution		Using solar power produces no pollution of any kind. - Solar stove	
Sun Quality of Life		Solar power does not produce smoke or other unpleasant fumes. - Solar stove	

Preference scores

Analysis	Okuryangava Study (OK and ON)	Demographic	Medium Income Demog
Scenario	Medium Income	Basket	Med #3

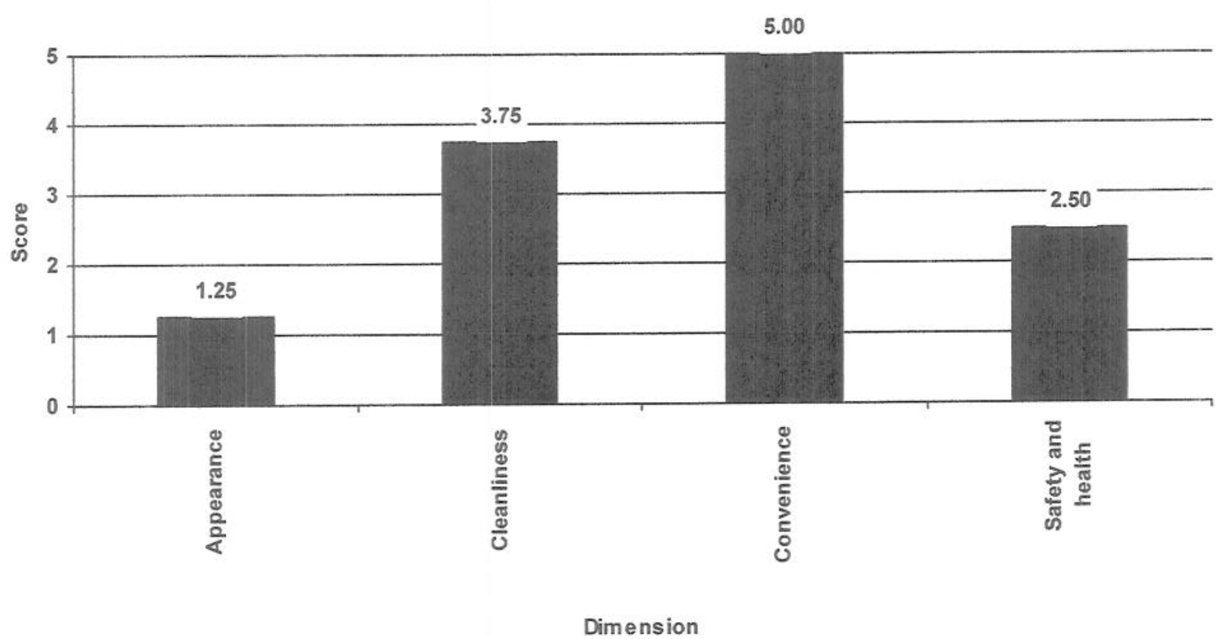
Hot water

Heating water for any purpose, e.g. beverages, dishes, personal, clothes washing.



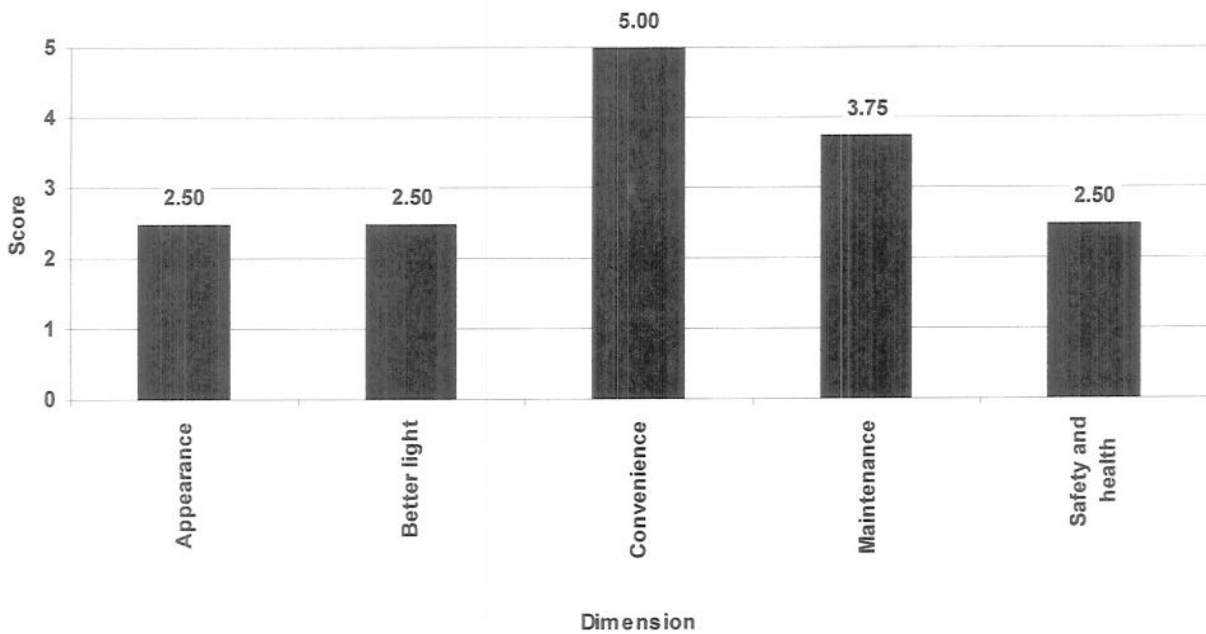
Ironing

Heating an iron (any type of iron)



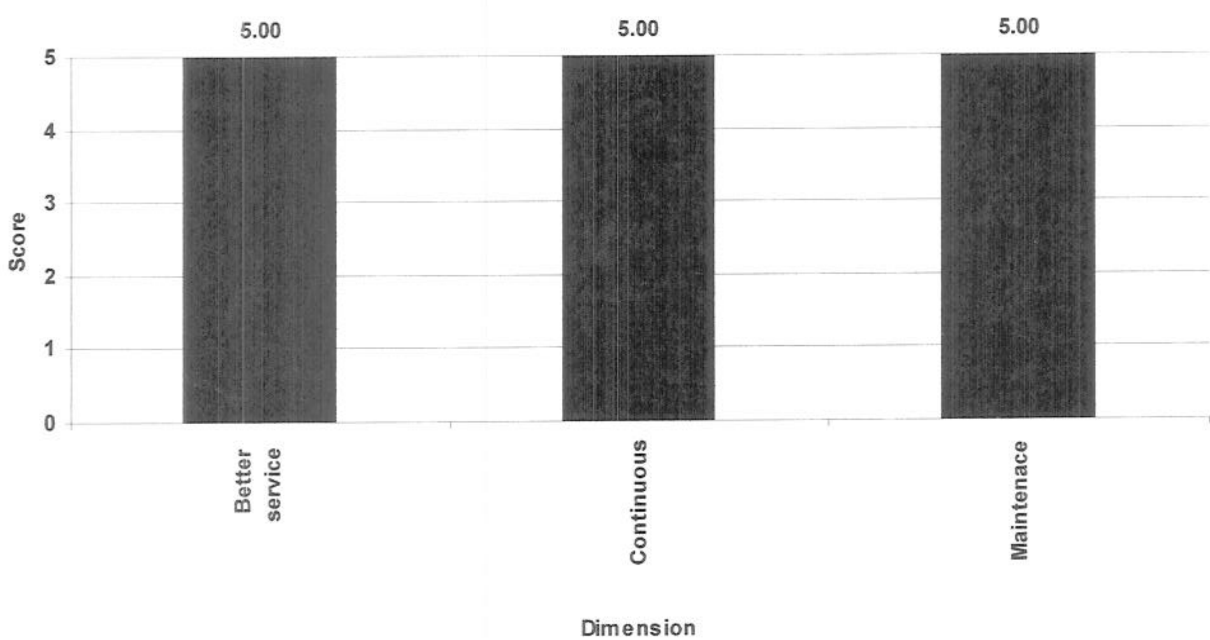
Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #3

Lighting



Media & Other Services

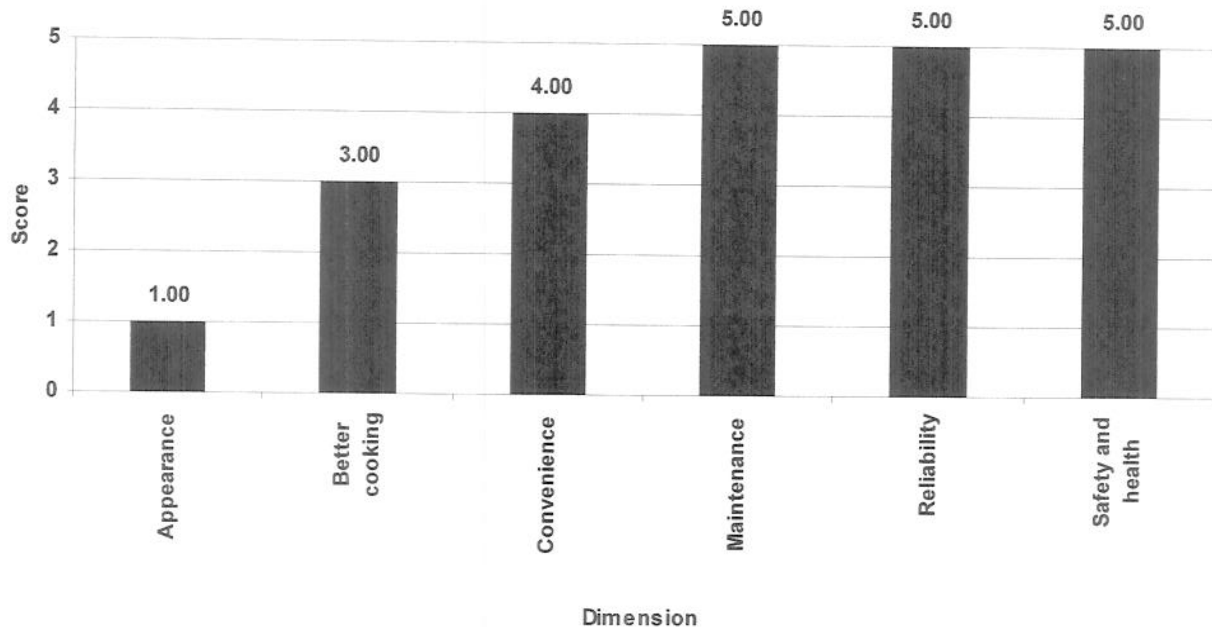
Supply of Electricity for any household appliance, not listed services, e.g. cooking.



Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #3

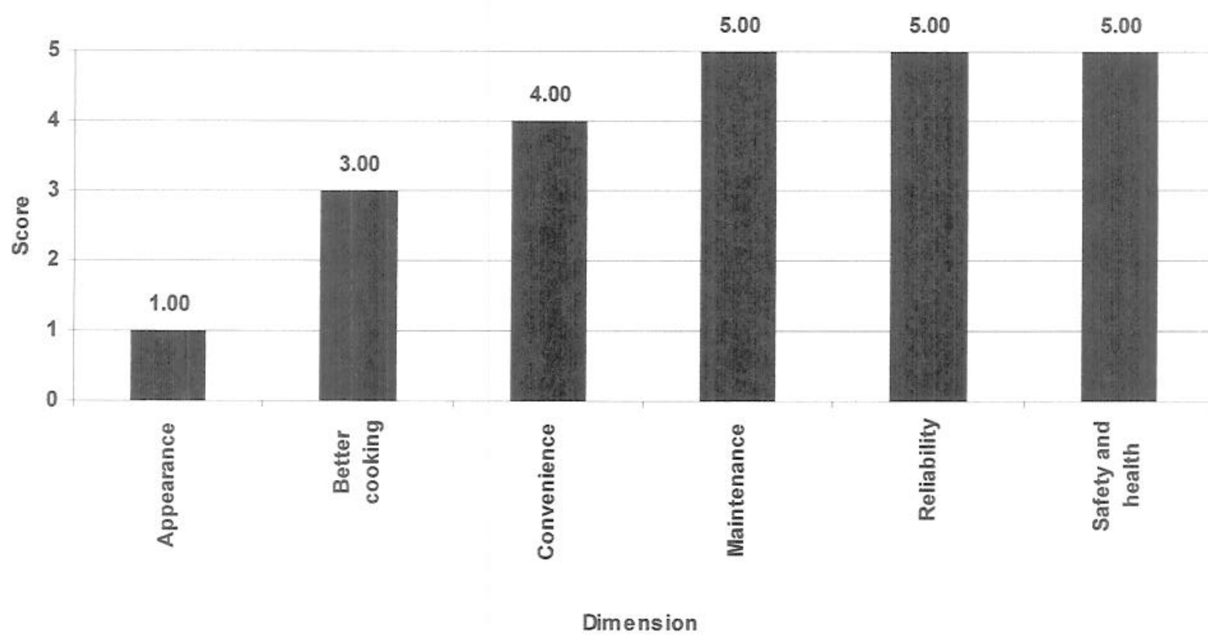
Plate cooking

Cooking with pots and pans, not grilling or baking



Refrigeration

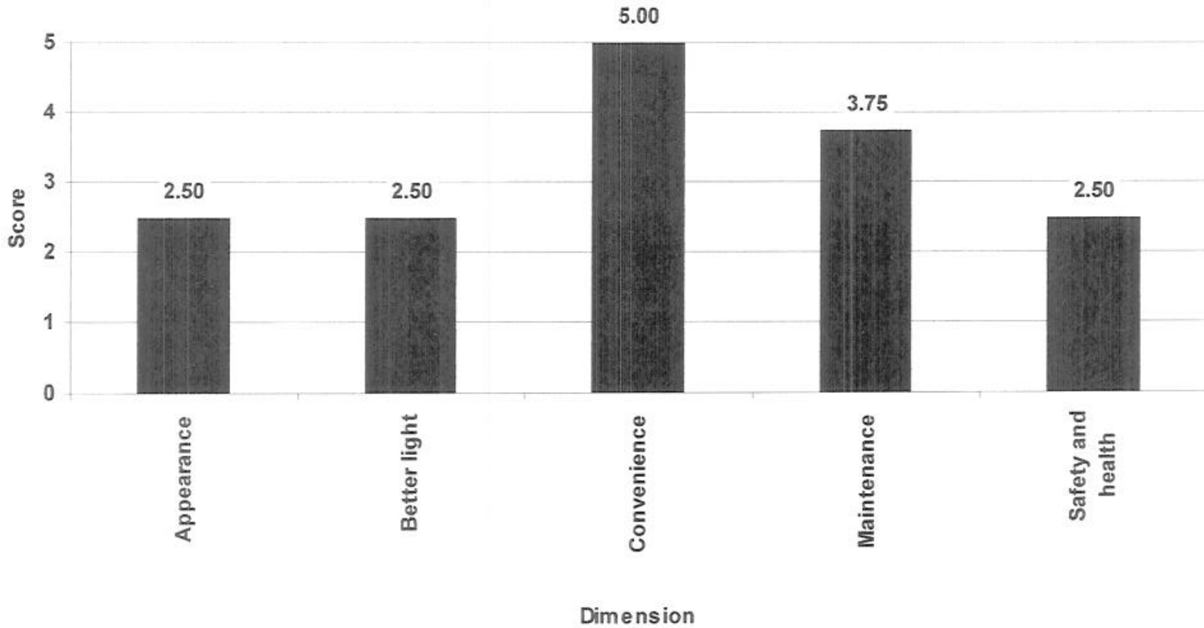
Refrigeration for cooling and storing perishable foodstuff



This report shows the average Scores against each Dimension of each Service for the Basket. The Scores take into account the Importance of each Dimension. If the Basket uses more than one Fuel to supply a particular Service then the Scores are the average Score. The Scores are adjusted so that the highest Score for any Dimension is always 5.

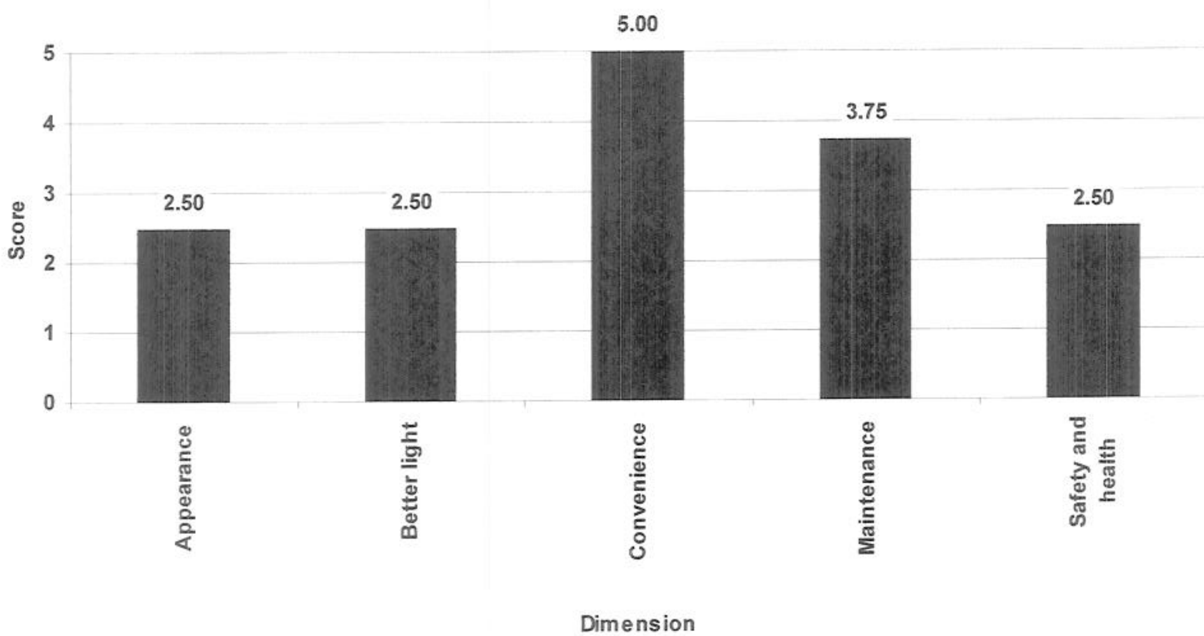
Analysis	Okuryangava Study (OK and ON)	**Demographic**	Medium Income Demog
Scenario	Medium Income	**Basket**	Med #4

Lighting



Media & Other Services

Supply of Electricity for any household appliance, not listed services, e.g. cooking.



Appendix G.6.7: All Analyses

Analyses

List of all of the analyses, demographics and scenarios stored in the EnPower model

Analysis	Okuryangava Study (OK and ON)	fake demographic used for calculating fuel consumption
Demographic	**fake 1**	fake demographic used for calculating fuel consumption
Scenario		No scenarios defined...
Demographic	**fake 3**	fake demographic used for calculating fuel consumption
Scenario		No scenarios defined...
Demographic	**fake 4**	fake demographic used for calculating fuel consumption
Scenario		No scenarios defined...
Demographic	**fake2**	fake demographic used for calculating fuel consumption
Scenario		No scenarios defined...
Demographic	**fake5**	fake demographic used for calculating fuel consumption
Scenario		No scenarios defined...
Demographic	**fake6**	fake demographic used for calculating fuel consumption
Scenario		No scenarios defined...
Demographic	**Low Income Demog**	Separate analysis for the lowest economic segment of the community. Represented by those houdeholds earning less than R1100 per month.
Scenario	*Low Income & fridge*	Low income with additional fridge option
Scenario	*Low income scenario*	Development of a range of potential baskets for the low income segment within Okuryangava. Those earning less than R1100 per month.
Demographic	**Medium Income Demog**	This demographic covers the middle income earners within the village those earning more than R1100
Scenario	*Medium Income*	Set of baskets aimed at the medium income level within Okuryangava ie those earning > R1100 per month

Appendix G.7: EnPower Storyboarding: Okuryangava, Namibia

EnPower Analysis

Okuryangava:
Okahandja Park & Ongulumbashe

Presentation overview:

This presentation material sets out a summary of information obtained during and from the application of the EnPower Toolkit process and analysis on a poor peri-urban community.

There is a logical flow to the way the information is presented. Starting with an overview of the process, the community is described through a range of descriptive factors, including the present levels of energy usage, appliance penetration and service levels. Next all the different options from the analysis are set out with defining attributes, such as fuel access and running costs, subsidies, appliance costs performance and preference levels and relative service levels. Each of the future possible options are referred to as "baskets," these are essentially a combination of fuels (energy) with associated appliances (energy converters) that would meet the minimum communities needs (services e.g. light).

These baskets would have been prepared for different economic levels or strata within the community. An income based segmentation being the most likely variable to reflect future energy expenditure in these marginalized communities.

Lastly the results of a stakeholder analysis reflect their expected reaction to the different offers. These can be used by the researcher/user to help managing the stakeholders.

Community details:

Community Name = Okahandja Park & Ongulumbashe

Village leader =

District = Okuryangava

Region = Khomas

Regional leader =

Researcher details:

Research name = Robert Schultz, Yvonne Mok, Erin Dupak, Justin Osgood

Organisation = R3E, MME, WPI

Telephone numbers = 081 2443063

Contact address = Polytechnic of Namibia

Community Contact =

Presentation Contents:

Overall Enpower Process and Progress

Stage A: Initialisation
- Training and equipping of users
- Identification of the community

Stage B: Situational Research
- Establishment of authority and permission to undertake the research
- Completion of On site initial situational research - DATE

Stage C: Detailed investigation and data gathering
- Supply side research – Identifying and costing all potential fuels and appliances
- Demand side research – Community research to obtain present fuel service and demographics data
- Stakeholder research – Identification, interest and strength assessment, plus basket analysis

Stage D: Calculation and basket design
- Raw data analysis
- Algorithm population
- Building and testing of possible baskets
- Printing of reports

Stage E: Storyboarding
- Storyboards for initial feedback
- Initial selection and reducing of options
- Storyboards for final feedback
- Decision making interaction between community and suppliers

Community description:

Okahandja Park and Ongulumbashe are located in the Okuryangava district of the Khomas Region, approximately 10 km from the nearest city of Windhoek, Namibia. The official language of Namibia is English. Several other languages spoken are Oshiwambo, Herero, Nama, Bushman (San), Afrikaans, and German. The Okuryangava district is an informally settled area of Windhoek and has a wide variety of ethnic groups including the Nama-Damara and the Oshiwambo. It has approximately 300-400 households with an average population of about 1000. The majority of the community members are domestic workers with some Pensioners as well as small-business owners. The source of income for the community members are pension from the government of Namibia to older citizens, private company and civil employment, and the female domestic workers. Presently the Okuryangava district is not legally electrified and fuel supply for cooking comes from purchased wood, LPG, and paraffin.

Geographic information:

Number of households = 350	Distance to nearest town = km
Size of population = 1000	Distance to major centre = 10 km
Distance between houses = 1.5 – 4.5 m	Village area = km^2

Community research sample demographic averages:

Total sample size = 36 interviews

Family average = 5.78 members

Adult males	= 1.50	School Children	= 1.25
Adult Females	= 1.42	Non-school children	= 1.61

Income average R 1100/month, and income bands

Low income band	R 0 to 1100/ month	Sample size = 23
Medium income band	R 1100+ /month	Sample size = 13

Expenditure averages – indication of what households spend their limited income on

Energy = 19%	Education = 4%	Services = 2%
Food = 47%	Transport = 13%	Other = 9%

Household improvement imperative (average of 3 choices allowed per household)

Education = 13.8	Housing = 50.0	Transport = 0.0
Energy = 86.1	Roads = 0.0	TV & Radio = 13.9
Food = 11.1	Telephone = 5.6	Water = 69.4
Health = 16.7		

Average house layout

# of structures = 1.1	# of rooms = 2.4	Household area = 29.3 m^2

Fuel options, associated appliances and notes:

This slide represents the major results of the detailed supply side research undertaken. Details are given on what fuels are available to the community, with their associated appliances and costs perspectives.

FUEL		
List of Fuel	Fuel Cost N$	Fuel Access Cost N$
4.5 kg Handi Gas (Purchase)	$ 44.00	$ 299.71
9 kg LPG Cylinder (Deposit)	$ 90.00	$ 130.00
Biogas	$ -	$ 5,000.00
Paraffin (20 litres)	$ 100.26	$ -
50 W SHS DC (complete with cabling, 3 lights 12V and 9 V sockets)	$ -	$ 6,000.00
100 W SHS DC (complete with cabling, 4 lights, 12V and 6 V socket)	$ -	$ 10,700.00
300 W SHS DC (complete with cabling, 4 lights, 12V and 6 V socket)		$ 29,700.00
SWER Grid connection per household	60c/kWh	$ 7,130.00

APPLIANCE			
List of Appliance in Basket	Appliance Cost N$	Maintenance Cost N$	Maintenance Frequency (months)
Evat Stove (medium)	$ 150.00	$ 150.00	36
100 L "Donkey" (not available yet, price determined)	$ 300.00	$ -	0
PV Lantern (1 light 11W with 9V socket)	$ 2,300.00	$ 700.00	36
Coal Iron	$ 84.45	$ -	0
Solar Box Cooker (medium)	$ 700.00	$ -	0
Low cost direct SWH (not available yet, price determined)	$ 600.00	$ 600.00	60
220 V Radio	$ 170.00	$ -	0
220 V HiFi (Radio and CD)	$ 1,706.00	$ -	0
220 V TV (colour) 37 cm	$ 1,379.00	$ -	0
220 V TV (colour) 51 cm	$ 1,429.00	$ -	0
CFL Light (11 Watt) DC	$ 273.00	$ 190.00	36
CFL Light (7 Watt) DC	$ 273.00	$ 190.00	36
CFL Light (11 Watt) AC	$ 30.00	$ 30.00	36
50 W SHS DC (complete with cabling, 3 lights 12V and 9 V sockets)	$ 6,000.00	$ 900.00	36
100 W SHS DC (complete with cabling, 4 lights, 12V and 6 V socket)	$ 10,700.00	$ 1,600.00	36
300 W SHS DC (complete with cabling, 4 lights, 12V and 6 V socket)	$ 29,700.00	$ 4,000.00	36
LPG Freezer (60 litres)	$ 4,227.00	$ -	0
12 V TV DC (B&W) 15 cm	$ 314.00	$ -	0
12 V TV DC (B&W) 37 cm	$ 2,530.00	$ -	0
12 V TV DC (colour)	$ 2,900.00	$ -	0
Radio DC (9 V)	$ 90.00	$ -	0
PV/solar powered Radio	$ 330.00	$ -	0
LPG single plate cooker (Handi Gas)	$ 90.00	$ -	0
LPG 2 Plate cooker	$ 240.00	$ -	0
LPG Iron	not available	not available	not available
DC and AC Freezer (40 liter)	$ 5,750.00	$ -	0
DC and AC Freezer (60 liter)	$ 7,250.00	$ -	0
DC and AC Freezer (115 liter)	$ 7,900.00	$ -	0
DC and AC Freezer (150 liter)	$ 8,800.00	$ -	0
2 cub.m. Biogas (materials only)	$ 5,000.00	$ -	0
2 Plate Biogas Cooker	$ 300.00	$ -	0
220 V Freezer (210 litre)	$ 1,650.00	$ -	0
220 V Fridge and Freezer (150 litre) EE	$ 6,200.00	$ -	0

Income level – Low: R 0.00 to R 1100.00 Sample questionnaires = 23

Current Fuel Usage on Average

Fuel	Unit	Unit Cost	Monthly Consumption		Penetration	Community Averages
			Units	N$		
Paraffin	liters	$5.00	6.13	$30.65	65%	$19.92
LP Gas	kg	$10.00	3.74	$37.40	30%	$11.22
Wood	kg	$1.13	93.02	$105.11	78%	$81.99
Candles	kg	$13.89	1.00	$13.89	74%	$10.28
Dry Cell Batteries	Vah	$0.45	47.78	$21.50	48%	$10.32
Car battery charging	Vah	$0.33	35.22	$11.62	17%	$1.98
						$135.71

Service Usage on Average

Appliance	Service	Yearly Use	Units	Penetration
Candle Holder	General lighting	1,249.19	hours/year	78.26%
Dry cell battery radio	Radio	1,282.75	hours/year	43.48%
Gas low pressure stove - double	Boiling water any purpose	1,168.00	litres/year	21.74%
Gas low pressure stove - double	Ironing	52.00	hours/year	4.35%
Gas low pressure stove - double	Medium heat	1,916.25	hours/year	26.09%
Gas low pressure stove - double	Rapid heating or frying	168.00	hours/year	4.35%
Gas low pressure stove - double	Warm washing water	227.50	litres/year	8.70%
Gas low pressure stove - single	Boiling water any purpose	7,300.00	litres/year	4.35%
Gas low pressure stove - single	Ironing	52.00	hours/year	4.35%
Gas low pressure stove - single	Medium heat	1,095.00	hours/year	4.35%
Low Power radio	Radio	1,355.50	hours/year	17.39%
Low-power electric television	Television	312.00	hours/year	4.35%
Paraffin lamp - regular	General lighting	1,348.35	hours/year	56.52%
Paraffin stove - wick double plate	Boiling water any purpose	759.38	litres/year	17.39%
Paraffin stove - wick double plate	Medium heat	1,805.63	hours/year	17.39%
Paraffin stove - wick double plate	Warm washing water	1,851.25	litres/year	17.39%
Paraffin wick stove - low cost single	Boiling water any purpose	365.00	litres/year	4.35%
Paraffin wick stove - low cost single	Medium heat	730.00	hours/year	8.70%
Paraffin wick stove - low cost single	Rapid heating or frying	337.50	hours/year	4.35%
Paraffin wick stove - low cost single	Warm washing water	5,475.00	litres/year	4.35%
Wood fire (open)	Baking food	152.60	hours/year	21.74%
Wood fire (open)	Boiling water any purpose	735.45	litres/year	47.83%
Wood fire (open)	Ironing	66.21	hours/year	60.87%
Wood fire (open)	Medium heat	1,269.17	hours/year	52.17%
Wood fire (open)	Simmering	2,920.00	hours/year	4.35%
Wood fire (open)	Warm washing water	2,314.92	litres/year	26.09%
Wood stove - pressed steel	Baking food	260.00	hours/year	4.35%
Wood stove - pressed steel	Boiling water any purpose	1,460.00	litres/year	4.35%
Wood stove - pressed steel	Ironing	52.00	hours/year	4.35%
Wood stove - pressed steel	Medium heat	6,570.00	hours/year	4.35%
Wood stove - pressed steel	Warm washing water	208.00	litres/year	4.35%

Income level – Medium: R 1100.00 + Sample questionnaires = 13

Current Fuel Usage on Average						
Fuel	Unit	Unit Cost	Monthly Consumption		Penetration	Community Averages
			Units	N$		
Paraffin	liters	$5.00	16.77	$83.85	85%	$71.27
LP Gas	kg	$10.00	4.77	$47.70	46%	$21.94
Wood	kg	$1.13	49.80	$56.27	62%	$34.89
Candles	kg	$13.89	0.53	$7.36	46%	$3.39
Dry Cell Batteries	Vah	$0.45	38.42	$17.29	23%	$3.98
Car battery charging	Vah	$0.33	221.53	$73.10	46%	$33.63
						$169.10

Service Usage on Average

Appliance	Service	Yearly Use	Units	Penetration
Candle Holder	General lighting	970.71	hours/year	53.85%
Dry cell battery radio	Radio	1,460.00	hours/year	30.77%
Gas lamp (LP 100 CP)	General lighting	912.50	hours/year	7.69%
Gas low pressure stove - double	purpose	958.13	litres/year	30.77%
Gas low pressure stove - double	Medium heat	1,688.13	hours/year	30.77%
Gas low pressure stove - double	frying	293.63	hours/year	30.77%
Gas low pressure stove - double	water	868.33	litres/year	23.08%
Gas refrigerator (100l)	Refrigerating food	348,000.00	hours/year	15.38%
Low power electric light 12 W CFL	General lighting	1,095.00	hours/year	7.69%
Low Power radio	Radio	1,460.00	hours/year	38.46%
Low-power electric television	Television	760.42	hours/year	23.08%
Paraffin lamp - regular	General lighting	2,279.29	hours/year	53.85%
Paraffin stove - wick double plate	purpose	1,112.33	litres/year	46.15%
Paraffin stove - wick double plate	Ironing	52.00	hours/year	7.69%
Paraffin stove - wick double plate	Medium heat	1,764.17	hours/year	46.15%
Paraffin stove - wick double plate	water	1,581.67	litres/year	23.08%
Paraffin wick stove - low cost single	purpose	730.00	litres/year	7.69%
Paraffin wick stove - low cost single	Ironing	52.00	hours/year	7.69%
Paraffin wick stove - low cost single	Medium heat	1,642.50	hours/year	7.69%
Paraffin wick stove - low cost single	frying	630.00	hours/year	15.38%
Paraffin wick stove - low cost single	water	730.00	litres/year	7.69%
Wood fire (open)	Baking food	52.00	hours/year	7.69%
Wood fire (open)	purpose	638.75	litres/year	15.38%
Wood fire (open)	Ironing	79.93	hours/year	53.85%
Wood fire (open)	Medium heat	1,277.50	hours/year	30.77%
Wood fire (open)	water	883.33	litres/year	23.08%

Low Income - Option 1 Basket Contents									
Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Dry cell battery radio	1	$90.00	$90.00	91.25	Vah/month	$0.45	$41.06	$0.00	
Solar Lantern	3	$2,300.00	$6,900.00	0.00			$0.00	$80.77	
Wood Evat Stove	1	$150.00	$150.00	125.61	kg/month	$1.13	$141.94	$4.17	
									TOTAL
TOTAL			$7,140.00				$183.00	$84.94	$7,407.94

Low Income - Option 2 Basket Contents									
Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - single	1	$90.00	$90.00	12.84	kg/month	$10.00	$128.40	$0.00	
Low power electric light 12 W CFL	3	$273.00	$819.00	209.87	Vah/month	$0.00	$0.00	$15.83	
Low Power radio	1	$330.00	$330.00	91.25	Vah/month	$0.00	$0.00	$0.00	
Solar stove - SWH	1	$600.00	$600.00	0.00		$0.00	$0.00	$10.00	
Solar PV 50	1	$6,000.00	$6,000.00				$0.00	$25.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71				$0.00	$0.00	
									TOTAL
TOTAL			$8,138.71				$128.40	$50.83	$8,317.94

Low Income - Option 3 Basket Contents									
Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - double	1	$240.00	$240.00	12.84	kg/month	$10.00	$128.40	$0.00	
High power electric light 20 W CFL	3	$100.00	$300.00	4.20	kWh/month	$0.00	$0.00	$0.00	
High power electric radio	1	$170.00	$170.00	0.46	kWh/month	$0.00	$0.00	$0.00	
Solar stove - SWH	1	$600.00	$600.00	0.00		$0.00	$0.00	$10.00	
PE 2.5 amp*	1	$5,000.00	$5,000.00	4.66		$0.70	$3.26	$0.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71				$0.00	$0.00	
									TOTAL
TOTAL			$6,609.71				$131.66	$10.00	$6,751.37

Basket comments:

The baskets presented here are for the low income level bracket.

* - prices to be further confirmed

Low Income - Option 4 Basket Contents									
Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - double	1	$240.00	$240.00	12.84	kg/month	$10.00	$128.40	$0.00	
Gas refrigerator (100l)	1	$4,227.00	$4,227.00	11.68	kg/month	$10.00	$116.80	$0.00	
Low power electric light 12 W CFL	3	$273.00	$819.00	209.87	Vah/month	$0.00	$0.00	$15.83	
Low Power radio	1	$330.00	$330.00	91.25	Vah/month	$0.00	$0.00	$0.00	
Solar stove - SWH	1	$600.00	$600.00	0.00		$0.00	$0.00	$10.00	
Solar PV 50	1	$6,000.00	$6,000.00				$0.00	$25.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71				$0.00	$0.00	
									TOTAL
TOTAL			$12,515.71				$245.20	$50.83	$12,811.74

Low Income - Option 5 Basket Contents									
Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - double	1	$240.00	$240.00	12.84	kg/month	$10.00	$128.40	$0.00	
Gas refrigerator (100l)	1	$4,227.00	$4,227.00	11.68	kg/month	$10.00	$116.80	$0.00	
High power electric light 20 W CFL	3	$100.00	$300.00	4.20	kWh/month	$0.00	$0.00	$0.00	
High power electric radio	1	$170.00	$170.00	0.46	kWh/month	$0.00	$0.00	$0.00	
Solar stove - SWH	1	$600.00	$600.00	0.00		$0.00	$0.00	$10.00	
PE 2.5 amp*	1	$5,000.00	$5,000.00	4.66		$0.70	$3.26	$0.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71				$0.00	$0.00	
									TOTAL
TOTAL			$10,836.71				$248.46	$10.00	$11,095.17

Low Income - Option 6 Basket Contents									
Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - double	1	$240.00	$240.00	12.84	kg/month	$10.00	$128.40	$0.00	
High power electric freezer (70l)	1	$1,300.00	$1,300.00	12.26	kWh/month	$0.00	$0.00	$0.00	
High power electric light 20 W CFL	3	$100.00	$300.00	4.20	kWh/month	$0.00	$0.00	$0.00	
High power electric radio	1	$170.00	$170.00	0.46	kWh/month	$0.00	$0.00	$0.00	
Solar stove - SWH	1	$600.00	$600.00	0.00		$0.00	$0.00	$10.00	
PE 2.5 amp*	1	$5,000.00	$5,000.00	16.92		$0.70	$11.84	$0.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71				$0.00	$0.00	
									TOTAL
TOTAL			$7,909.71				$140.24	$10.00	$8,059.95

Basket comments:

The baskets presented here are for the low income level bracket with refrigerator options.

* - prices to be further confirmed

Medium Income - Option 1 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	TOTAL
Gas low pressure stove - single	1	$90.00	$90.00	12.84	kg/month	$10.00	$128.40	$0.00	
Gas refrigerator (100l)	1	$4,227.00	$4,227.00	11.68	kg/month	$10.00	$116.80	$0.00	
Low power electric light 12 W CFL	3	$273.00	$819.00	349.79	Vah/month	$0.00	$0.00	$15.83	
Low Power radio	1	$330.00	$330.00	121.67	Vah/month	$0.00	$0.00	$0.00	
Low-power electric television	1	$314.00	$314.00	730.00	Vah/month	$0.00	$0.00	$0.00	
Solar stove - SWH	1	$600.00	$600.00	0.00		$0.00	$0.00	$10.00	
Solar PV 50	1	$6,000.00	$6,000.00				$0.00	$25.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71				$0.00	$0.00	
TOTAL			$12,679.71				$245.20	$50.83	$12,975.74

Medium Income - Option 2 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	TOTAL
Gas low pressure stove - single	1	$90.00	$90.00	12.84	kg/month	$10.00	$128.40	$0.00	
Gas refrigerator (100l)	1	$4,227.00	$4,227.00	11.68	kg/month	$10.00	$116.80	$0.00	
Low power electric light 12 W CFL	5	$273.00	$1,365.00	349.79	Vah/month	$0.00	$0.00	$26.39	
Low Power radio	1	$330.00	$330.00	121.67	Vah/month	$0.00	$0.00	$0.00	
Low-power electric television	1	$314.00	$314.00	730.00	Vah/month	$0.00	$0.00	$0.00	
Solar stove - SWH	1	$600.00	$600.00	0.00		$0.00	$0.00	$10.00	
Solar PV 100	1	$10,700.00	$10,700.00				$0.00	$44.44	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71				$0.00	$0.00	
TOTAL			$17,925.71				$245.20	$80.83	$18,251.74

Basket comments:

The baskets presented here are for the medium income level bracket.

Medium Income - Option 3 Basket Contents									
Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - double	1	$240.00	$240.00	12.84	kg/month	$10.00	$128.40	$0.00	
High power electric freezer (70l)	1	$1,300.00	$1,300.00	12.26	kWh/month	$0.00	$0.00	$0.00	
High power electric radio	1	$170.00	$170.00	0.61	kWh/month	$0.00	$0.00	$0.00	
High power electric television	1	$1,379.00	$1,379.00	0.77	kWh/month	$0.00	$0.00	$0.00	
Low power electric light 12 W CFL	5	$273.00	$1,365.00	349.79	Vah/month	$0.00	$0.00	$26.39	
Solar stove - SWH	1	$600.00	$600.00	0.00		$0.00	$0.00	$10.00	
Solar PV 300	1	$29,700.00	$29,700.00				$0.00	$111.11	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71				$0.00	$0.00	
									TOTAL
TOTAL			$35,053.71				$128.40	$147.50	$35,329.61

Medium Income - Option 4 Basket Contents									
Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas stove with oven	1	$1,370.00	$1,370.00	15.00	kg/month	$10.00	$150.00	$0.00	
High power electric freezer (70l)	1	$1,300.00	$1,300.00	12.26	kWh/month	$0.00	$0.00	$0.00	
High power electric light 60W incandescent	5	$54.00	$270.00	21.60	kWh/month	$0.00	$0.00	$0.00	
High power electric radio	1	$170.00	$170.00	0.61	kWh/month	$0.00	$0.00	$0.00	
High power electric television	1	$1,379.00	$1,379.00	0.77	kWh/month	$0.00	$0.00	$0.00	
Solar stove - SWH	1	$600.00	$600.00	0.00		$0.00	$0.00	$10.00	
PE 2.5 amp *	1	$5,000.00	$5,000.00	35.24		$0.70	$24.67	$0.00	
9 kg LPG Cylinder (deposit)	1	$130.00	$130.00				$0.00	$0.00	
									TOTAL
TOTAL			$10,219.00				$174.67	$10.00	$10,403.67

Basket comments:

The baskets presented here are for the medium income level bracket.

* - price to be confirmed

Stakeholder Analysis - Relative strength and low basket rating								
Stakeholders			Baskets scored on a 1 to 10 scale					
#	Name	Strength	Basket 1	Basket 2	Basket 3	Basket 4	Basket 5	Basket 6
1	Community	20%	5.3	6.5	7.5	5.3	6	8.3
2	GEL Church	30%	5	6	7	8	9	10
3	Municipality	40%	5.2	5.8	7.9	6.7	8.8	9.8
4	MME	10%	5.3	6	7.3	7.1	8.1	8.5
	Overall Scores	**100%**	**5.16**	**6.02**	**7.49**	**6.84**	**8.23**	**9.42**

Stakeholder Analysis - Relative strength and medium basket rating								
Stakeholders			Baskets scored on a 1 to 10 scale					
#	Name	Strength	Basket 1	Basket 2	Basket 3	Basket 4		
1	Community	20%	5	5	6	9.5		
2	GEL Church	30%	4	6	8	10		
3	Municipality	40%	4.5	5.9	6.5	10		
4	MME	10%	5.8	6.6	7.4	8.5		
	Overall Scores	**100%**	**4.58**	**5.82**	**6.94**	**9.75**		

Stakeholder Analysis Comments:

1. The above list have been identified as the organisations or persons that will have the greatest say in what is delivered to the community.

Date: April 25, 2003

Time: 11:30 a.m.

Location: Engineering Building, Conference Room

Attendees: Robert Shultz of R-3-E; Erin Dupak, Yvonne Mok and Justin Osgood, from the EnPower Team; Creighton Peet and Steve Pierson, from WPI, Nils Wormsbächer, Heike Cronje of the City of Windhoek and Hugo Rust of the City of Windhoek, Department of Sustainable Development; Pastor Petrus and Vicar Colete, from the Gowaseb Lutheran Church; and Christopher Bean, Elizabeth Norgard, and Lindsay Wright from the UDV Team.

Appendix G.8:
R-3-E Generated Basket Figures

APPENDIX F.8

R-3-E Generated Basket Calculations

Present Fuel Usage:

Low income

Low Income - Current Fuel Usage on Average						
Fuel	Unit	Unit Cost	Monthly Consumption		Penetration	Community Averages
			Units	N$		
Paraffin	liters	$5.00	6.13	$30.65	65%	$19.92
LP Gas	kg	$10.00	3.74	$37.40	30%	$11.22
Wood	kg	$1.13	93.02	$105.11	78%	$81.99
Candles	kg	$13.89	1.00	$13.89	74%	$10.28
Dry Cell Batteries	Vah	$0.45	47.78	$21.50	48%	$10.32
Car battery charging	Vah	$0.33	35.22	$11.62	17%	$1.98
						$135.71

Medium income

Medium Income - Current Fuel Usage on Average						
Fuel	Unit	Unit Cost	Monthly Consumption		Penetration	Community Averages
			Units	N$		
Paraffin	liters	$5.00	16.77	$83.85	85%	$71.27
LP Gas	kg	$10.00	4.77	$47.70	46%	$21.94
Wood	kg	$1.13	49.80	$56.27	62%	$34.89
Candles	kg	$13.89	0.53	$7.36	46%	$3.39
Dry Cell Batteries	Vah	$0.45	38.42	$17.29	23%	$3.98
Car battery charging	Vah	$0.33	221.53	$73.10	46%	$33.63
						$169.10

Low Income Level Baskets:

Low #1

Low Income - Option 1 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Dry cell battery radio	1	$90.00	$90.00	91.25	Vah/month	$0.45	$41.06	$0.00	Monthly cost
Solar Lantern	3	$2,300.00	$6,900.00	0.00	~	$0.00	$0.00	$58.33	$245.50
Wood Evat Stove	1	$150.00	$150.00	125.61	kg/month	$1.13	$141.94	$4.17	
									TOTAL
TOTAL			$7,140.00				$183.00	$62.50	$7,385.50

Low #2

Low Income - Option 2 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - single	1	$90.00	$90.00	12.84	kg/month	$10.00	$128.40	$0.00	
Low power electric light 12 W CFL	3	$273.00	$819.00	209.87	Vah/month	$0.00	$0.00	$15.83	
Low Power radio	1	$330.00	$330.00	91.25	Vah/month	$0.00	$0.00	$0.00	Monthly cost
Solar stove - SWH	1	$600.00	$600.00	0.00	~	$0.00	$0.00	$10.00	$179.23
Solar PV 50	1	$6,000.00	$6,000.00	~	~	~	~	$25.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71	~	~	~	~	$0.00	
									TOTAL
TOTAL			$8,138.71				$128.40	$50.83	$8,317.94

Low #3

Low Income - Option 3 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - double	1	$240.00	$240.00	12.84	kg/month	$10.00	$128.40	$0.00	
High power electric light 20 W CFL	3	$100.00	$300.00	4.20	kWh/month	$0.70	$2.94	$0.00	
High power electric radio	1	$170.00	$170.00	0.46	kWh/month	$0.70	$0.32	$0.00	Monthly cost
Solar stove - SWH	1	$600.00	$600.00	0.00	~	$0.00	$0.00	$10.00	$141.66
PE 2.5 amp*	1	$5,000.00	$5,000.00	~	~	~	~	$0.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71	~	~	~	~	$0.00	
									TOTAL
TOTAL			$6,609.71				$131.66	$10.00	$6,751.37

Low #4

Low Income - Option 4 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - double	1	$240.00	$240.00	12.84	kg/month	$10.00	$128.40	$0.00	
Gas refrigerator (100l)	1	$4,227.00	$4,227.00	11.68	kg/month	$10.00	$116.80	$0.00	
Low power electric light 12 W CFL	3	$273.00	$819.00	209.87	Vah/month	$0.00	$0.00	$15.83	
Low Power radio	1	$330.00	$330.00	91.25	Vah/month	$0.00	$0.00	$0.00	Monthly cost
Solar stove - SWH	1	$600.00	$600.00	0.00	~	$0.00	$0.00	$10.00	$296.03
Solar PV 50	1	$6,000.00	$6,000.00	~	~	~	~	$25.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71	~	~	~	~	$0.00	
									TOTAL
TOTAL			$12,515.71				$245.20	$50.83	$12,811.74

Low #5

Low Income - Option 5 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - double	1	$240.00	$240.00	12.84	kg/month	$10.00	$128.40	$0.00	
Gas refrigerator (100l)	1	$4,227.00	$4,227.00	11.68	kg/month	$10.00	$116.80	$0.00	
High power electric light 20 W CFL	3	$100.00	$300.00	4.20	kWh/month	$0.70	$2.94	$0.00	
High power electric radio	1	$170.00	$170.00	0.46	kWh/month	$0.70	$0.32	$0.00	Monthly cost
Solar stove - SWH	1	$600.00	$600.00	0.00	~	$0.00	$0.00	$10.00	$258.46
PE 2.5 amp*	1	$5,000.00	$5,000.00	~	~	~	~	$0.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71	~	~	~	~	$0.00	
									TOTAL
TOTAL			$10,836.71				$248.46	$10.00	$11,095.17

Low #6

Low Income - Option 6 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - double	1	$240.00	$240.00	12.84	kg/month	$10.00	$128.40	$0.00	
High power electric freezer (70l)	1	$1,300.00	$1,300.00	12.26	kWh/month	$0.00	$0.00	$0.00	
High power electric light 20 W CFL	3	$100.00	$300.00	4.20	kWh/month	$0.70	$2.94	$0.00	
High power electric radio	1	$170.00	$170.00	0.46	kWh/month	$0.70	$0.32	$0.00	Monthly cost
Solar stove - SWH	1	$600.00	$600.00	0.00	~	$0.00	$0.00	$10.00	$141.66
PE 2.5 amp*	1	$5,000.00	$5,000.00	~	~	~	~	$0.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71	~	~	~	~	$0.00	
									TOTAL
TOTAL			$7,909.71				$131.66	$10.00	$8,051.37

Medium Income Level Baskets:

Medium #1

Medium Income - Option 1 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - single	1	$90.00	$90.00	12.84	kg/month	$10.00	$128.40	$0.00	
Gas refrigerator (100l)	1	$4,227.00	$4,227.00	11.68	kg/month	$10.00	$116.80	$0.00	
Low power electric light 12 W CFL	3	$273.00	$819.00	349.79	Vah/month	$0.00	$0.00	$15.83	
Low Power radio	1	$330.00	$330.00	121.67	Vah/month	$0.00	$0.00	$0.00	
Low-power electric television	1	$314.00	$314.00	730.00	Vah/month	$0.00	$0.00	$0.00	Monthly cost
Solar stove - SWH	1	$600.00	$600.00	0.00	~	$0.00	$0.00	$10.00	$296.03
Solar PV 50	1	$6,000.00	$6,000.00	~	~	~	~	$25.00	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71	~	~	~	~	$0.00	
									TOTAL
TOTAL			$12,679.71				$245.20	$50.83	$12,975.74

Medium #2

Medium Income - Option 2 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - single	1	$90.00	$90.00	12.84	kg/month	$10.00	$128.40	$0.00	
Gas refrigerator (100l)	1	$4,227.00	$4,227.00	11.68	kg/month	$10.00	$116.80	$0.00	
Low power electric light 12 W CFL	5	$273.00	$1,365.00	349.79	Vah/month	$0.00	$0.00	$26.39	
Low Power radio	1	$330.00	$330.00	121.67	Vah/month	$0.00	$0.00	$0.00	
Low-power electric television	1	$314.00	$314.00	730.00	Vah/month	$0.00	$0.00	$0.00	Monthly cost
Solar stove - SWH	1	$600.00	$600.00	0.00	~	$0.00	$0.00	$10.00	$326.03
Solar PV 100	1	$10,700.00	$10,700.00	~	~	~	~	$44.44	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71	~	~	~	~	$0.00	
									TOTAL
TOTAL			$17,925.71				$245.20	$80.83	$18,251.74

Medium #3

Medium Income - Option 3 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - double	1	$240.00	$240.00	12.84	kg/month	$10.00	$128.40	$0.00	
High power electric freezer (70l)	1	$1,300.00	$1,300.00	12.26	kWh/month	$0.00	$0.00	$0.00	
High power electric radio	1	$170.00	$170.00	0.61	kWh/month	$0.00	$0.00	$0.00	
High power electric television	1	$1,379.00	$1,379.00	0.77	kWh/month	$0.00	$0.00	$0.00	
Low power electric light 12 W CFL	5	$273.00	$1,365.00	349.79	Vah/month	$0.00	$0.00	$26.39	Monthly cost
Solar stove - SWH	1	$600.00	$600.00	0.00	~	$0.00	$0.00	$10.00	$275.90
Solar PV 300	1	$29,700.00	$29,700.00	~	~	~	~	$111.11	
4.5 kg Handi Gas (Purchase)	1	$299.71	$299.71	~	~	~	~	$0.00	
									TOTAL
TOTAL			$35,053.71				$128.40	$147.50	$35,329.61

Medium #4

Medium Income - Option 4 Basket Contents

Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel subtotal	Required energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas stove with oven	1	$1,370.00	$1,370.00	15.00	kg/month	$10.00	$150.00	$0.00	
High power electric freezer (70l)	1	$1,300.00	$1,300.00	12.26	kWh/month	$0.70	$8.58	$0.00	
High power electric light 60W incandescent	5	$54.00	$270.00	21.60	kWh/month	$0.70	$15.12	$0.00	
High power electric radio	1	$170.00	$170.00	0.61	kWh/month	$0.70	$0.43	$0.00	
High power electric television	1	$1,379.00	$1,379.00	0.77	kWh/month	$0.70	$0.54	$0.00	Monthly cost
Solar stove - SWH	1	$600.00	$600.00	0.00	~	$0.00	$0.00	$10.00	$184.67
PE 2.5 amp *	1	$5,000.00	$5,000.00	~	~	~	~	$0.00	
9 kg LPG Cylinder (deposit)	1	$130.00	$130.00	~	~	~	$0.00	$0.00	
									TOTAL
TOTAL			$10,219.00				$174.67	$10.00	$10,403.67

Appendix H: Project Photographs

APPENDIX H

This appendix is dedicated to relevant photographs and maps of Okahandja Park and Ongulumbashe (Okuryangava), Namibia.
Photographs by: Erin Dupak.

Area map of Okahandja Park (areas 3,4 &5) and Ongulumbashe (area 6)

J. Osgood, Y. Mok & R. Schultz in front of the Gowaseb Lutheran Church in Okuryangava, Namibia (March 26, 2003)

View of the Gowaseb Lutheran Church in Ongulumbashe, Namibia, from the “Illegally Container”, a local shebeen (March 26, 2003)

A shebeen in Okahandja Park, Namibia, located near a solar panel telephone booth (March 26, 2003)

Street market in Ongulumbashe, Namibia (March 26, 2003)


Hilltop view of Ongulumbashe, Namibia, from the Gowaseb Lutheran Church (March 26, 2003)

Household (left) and toilet (right) in Ongulumbashe, Namibia (March 26, 2003)

J. Osgood & Y. Mok with our 3 translators (March 27, 2003)

BIOMASS: N$5.00 bundles of firewood for sale (March 27, 2003)

A residence in Okuryangava (March 27, 2003)

Team EnPower overlooking Ongulumbashe: J. Osgood, E. Dupak & Y. Mok (April 2, 2003)
(Photograph courtesy of Lisa Sasaur)

Ongulumbashe at nightfall (April 2, 2003)

EnPower/UDV Meeting with Hugo Rust and other city officials: Y. Mok, L. Wright, J. Osgood, C. Bean & E. Norgard (April 3, 2003)

Pastor Petrus, J. Osgood, Y. Mok & Vicar Colete (April 25, 2003)

L. Wright, C. Peet, C. Bean, Niels ? , R. Schultz, J. Osgood, Y. Mok (April 25, 2003)

H, Rust, Female representative from the City of Windhoek, S. Pierson (April 25, 2003)

Pastor Petrus, Y. Mok, Vicar Colete, J. Osgood (April 25, 2003)

C. Peet, Niels ?, S. Pierson (April 25, 2003)

Appendix I:
Presentation of
“An Evaluation of EnPower in Informally Settled Areas: A Case Study in Okuryangava, Namibia”

An Evaluation of EnPower in Informally Settled Areas:

A Case Study in Okuryangava, Namibia

Worcester Polytechnic Institute

R-3-E

Erin Dupak
Yvonne Mok
Justin Osgood

April 30, 2003

Overview of Presentation

- Introduce the Project
- Explain our Methodology
- Present our Findings & Recommendations
- Present our Conclusions
- Comments & Questions

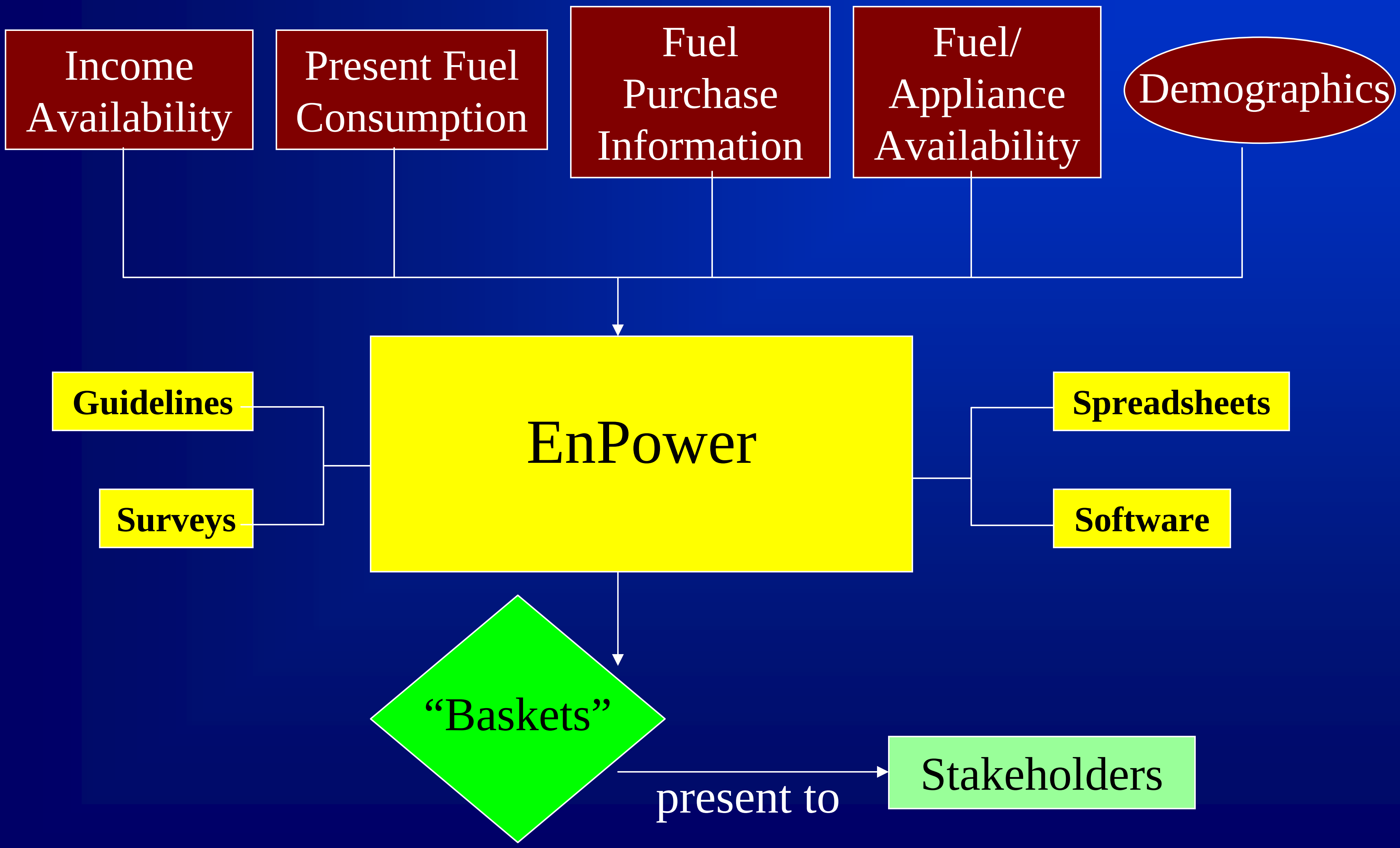
Problem Statement

The people in rural and peri-urban areas of Namibia have a demand for unavailable modern energy services.

EnPower

- EnPower’s Goal:
  - To be “an appraisal tool, which helps poor communities have a voice in the energy investment decisions that affect them”
- What is EnPower?
  - Tools for the process of collecting and analyzing data on energy use and needs for energy solutions

EnPower Overview



Our Goal and Objectives

Goal:

- To evaluate the EnPower process and develop recommendations about its applicability to Namibian communities

Objectives:

- Obtain a thorough understanding of the EnPower process
- Synthesize suggestions to tailor the EnPower process to Namibia

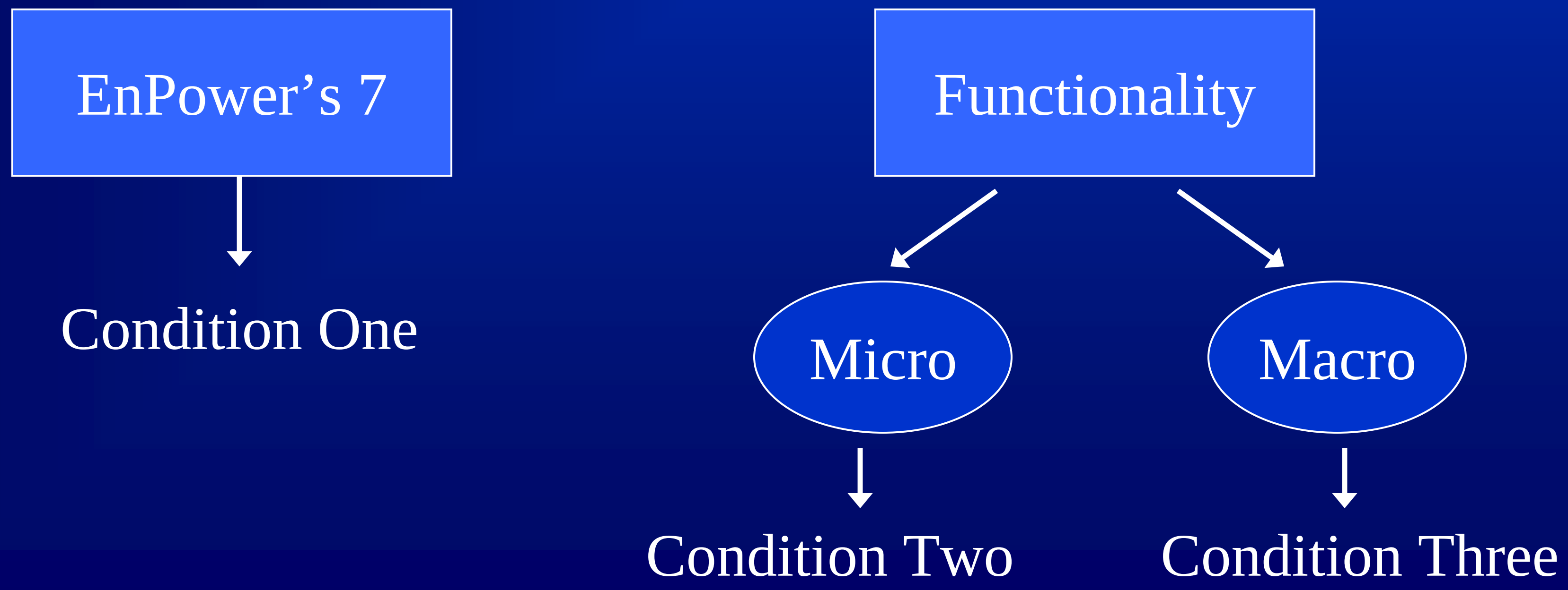
Our Methodology

1. Setup criteria & indicators for evaluating objectives – Evaluation Framework for EnPower (EFFE)
2. Analyze and review toolkit, and add our own changes to make the process more effective
3. Implement the EnPower process
4. Evaluate EnPower using EFFE

Evaluation Framework for EnPower

We evaluated EnPower on:

- Whether EnPower's 7 objectives were met
- How well EnPower's 7 objectives were met



EnPower's 7

Condition One

EnPower objective areas:

1. Identifying community member's energy needs.
2. Offer complete energy solutions that satisfy the community's needs.
3. Involving relevant stakeholders to gain support for a complete energy solution.

Functionality

Micro

Macro

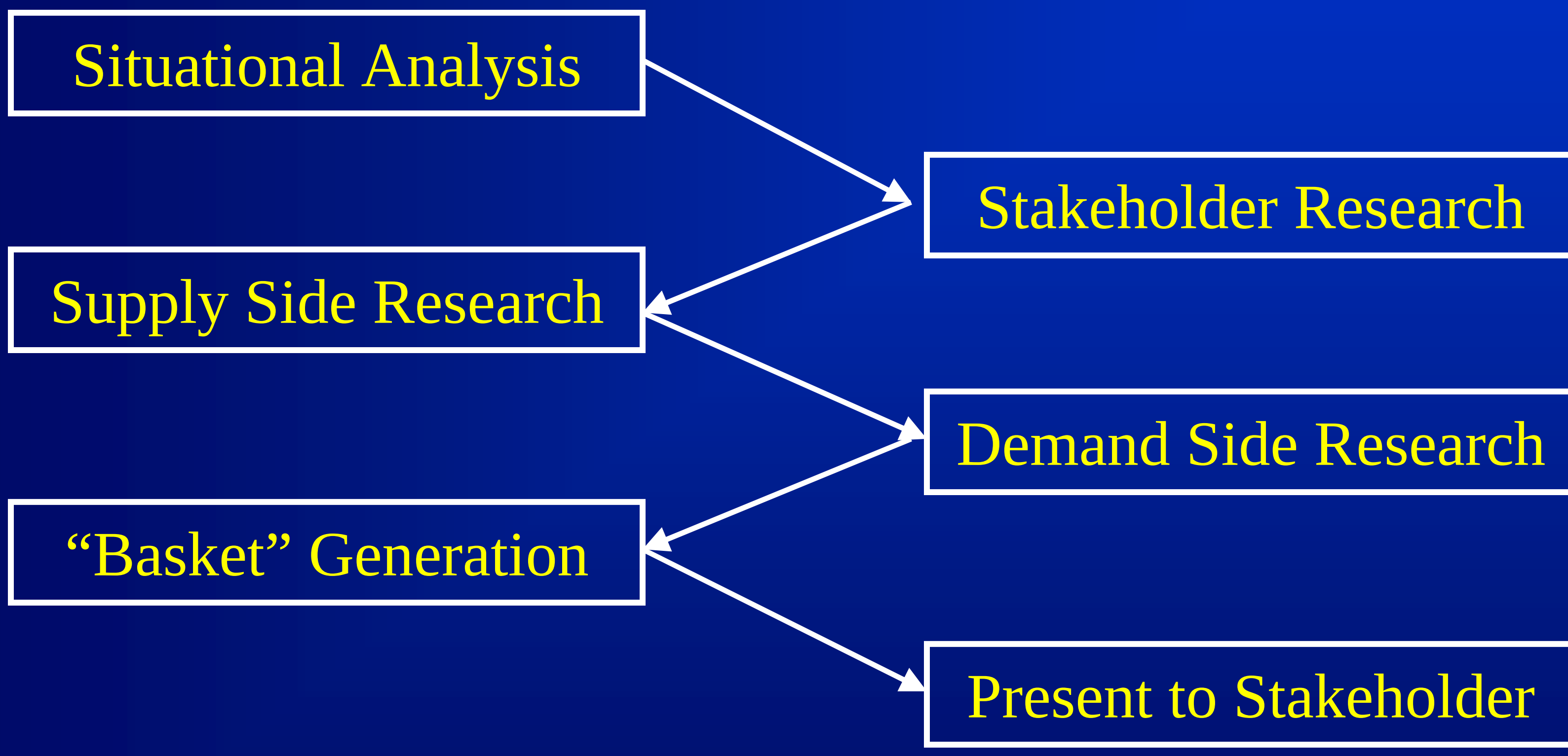
Condition Two

- Easy and efficiency of data collection
- Ease and efficiency of data analysis

Condition Three

- Ease and efficiency of entire process
- Level acceptance of stakeholders

EnPower Process



Okuryangava, Namibia

- Okahandja Park
  & Ongulumbashe

- Households: 350/1400
- Average household size: 5.8/4.5 people
- Average income (N$/per month): 1100/750
- Fuels used: wood, paraffin, LPG, candle, dry cell battery, low power elec.

Fuel Consumption

Low Income - Current Fuel Usage on Average				
Fuel	Unit	Monthly Consumption		Penetration
		Units	N$	
Paraffin	liters	6.13	$30.65	65%
LP Gas	kg	3.74	$37.40	30%
Wood	kg	93.02	$105.11	78%
Candles	kg	1.00	$13.89	74%
Dry Cell Batteries	Vah	47.78	$21.50	48%
Car battery charging	Vah	35.22	$11.62	17%

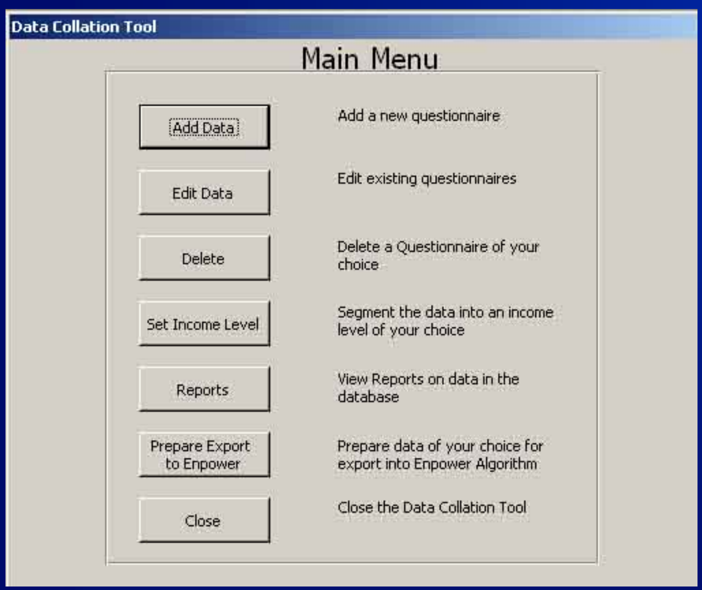
Medium Income - Current Fuel Usage on Average				
Fuel	Unit	Monthly Consumption		Penetration
		Units	N$	
Paraffin	liters	16.77	$83.85	85%
LP Gas	kg	4.77	$47.70	46%
Wood	kg	49.80	$56.27	62%
Candles	kg	0.53	$7.36	46%
Dry Cell Batteries	Vah	38.42	$17.29	23%
Car battery charging	Vah	221.53	$73.10	46%

Group Preference Ranking

Cooking	Paraffin	LP Gas	Wood/ Waste	Wood Stove	Charcoal	Solar Cooker	Grid Electricity	Score	Ranking
Paraffin		LPG	P	P	P	P	E	4	3RD
LP Gas			LPG	LPG	LPG	LPG	E	5	2ND
Wood/ Waste				WS	W	W	E	2	5TH
Wood Stove					WS	WS	E	3	4TH
Charcoal						C	E	1	6TH
Solar Cooker							E	0	7TH
Grid Electricity								6	1ST

Data Entry & Analysis

- Data Collation Tool
- EnPower Algorithm



Generated Baskets

Low Income #1

Appliance / Fuel Equipment	Qty	Appliance / Fuel Equipment Cost	Unit Cost	Units	Monthly Fuel Cost	Monthly Maintenance Cost	
Dry cell battery radio	1	$90.00	$0.45	Vah/month	$40.50	$0.00	**Monthly Cost**
Solar Lantern	3	$2,300.00	$0.00	~	$0.00	$58.33	**$272.50**
Wood Evat Stove	1	$150.00	$1.13	kg/month	$169.50	$4.17	
							TOTAL
Total		$7,140.00			$210.00	$62.50	**$7,412.50**

Low Income #2

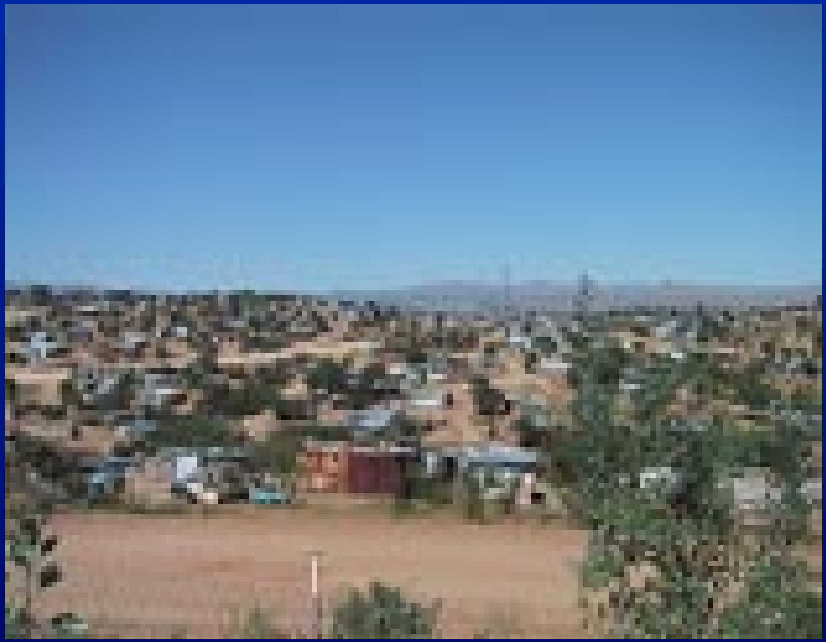
Appliance / Fuel Equipment	Qty	Appliance / Fuel Equipment Cost	Unit Cost	Units	Monthly Fuel Cost	Monthly Maintenance Cost	
Gas low pressure stove - single	1	$90.00	$10.00	kg/month	$128.40	$0.00	
Low power electric light 12 W CFL	3	$273.00	$0.00	Vah/month	$0.00	$15.83	
Low Power radio	1	$330.00	$0.00	Vah/month	$0.00	$0.00	
Solar stove - SWH	1	$600.00	$0.00	~	$0.00	$10.00	
							Monthly Cost
Solar PV 50	1	$6,000.00	~	~	~	$25.00	**$179.23**
4.5 kg Handi Gas (Purchase)	1	$299.71	~	~	~	$0.00	
							TOTAL
Total		$8,138.71			$128.40	$50.83	**$8,317.94**

Presentation to Stakeholders

Findings & Recommendations

Overview

- Condition One: EnPower's 7
- Condition Two: Functionality Micro
- Condition Three: Functionality Macro



Condition One: EnPower's 7

- Criteria that passed:
  - The information collected is complete, relevant, useful and used
  - Stakeholders' support is maintained
  - No outside influence on the community is allowed
  - The generated baskets accommodate community/individual needs and resources

- Criteria yet to be evaluated:
  - All stakeholders, including community members, agree upon implementing one of the proposed baskets per income level

- Criteria that failed:
  - Data analysis and report generation are successful

Condition Two: Functionality Micro

Main Phases:

- Data Gathering
- Basket Generation
  - Successful except for report generation
- Presentation to Stakeholders

Condition Three: Functionality Macro

- Overall process was easy and efficient
  - Time frames allotted for each phase was sufficient.
  - Need to emphasize that phases should be done sequentially and do not overlap.
- Stakeholders accept the EnPower process
  - Has yet to be determined

Conclusions

- Concept of EnPower is valid.
- EnPower process easily adjusts to a community.
- EnPower shows a lot of potential.
- EnPower Toolkit needs to be further refined and developed.

Acknowledgements

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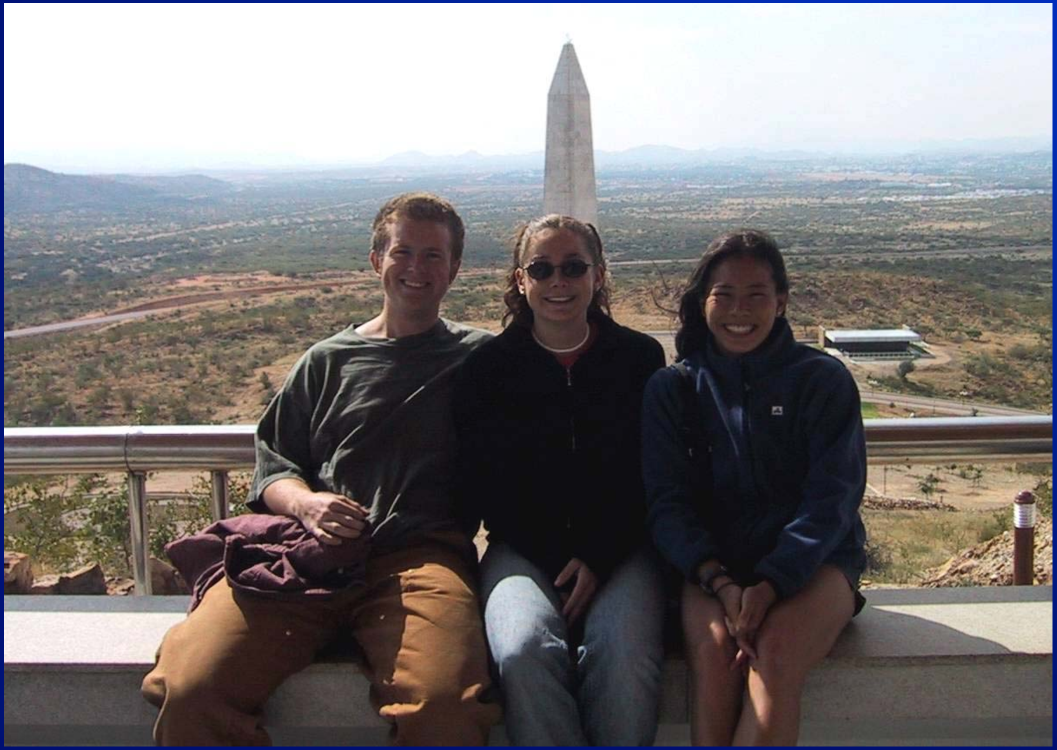
City of Windhoek

Comments / Questions



Justin Osgood, Erin Dupak, Yvonne Mok