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BOTSWANA URBAN DOMESTIC ENERGY USE AND ATTITUDE SURVEY

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ACRONYMS

BRET	Botswana Renewable Energy Technology project
GOB	Government of Botswana
MMRWA	Ministry of Mineral Resources and Water Affairs
USAID	U. S. Agency for International Development
MLGL	Ministry of Local Government and Lands
RET	renewable energy technology
NDP-5	National Development Plan
BPC	Botswana Power Corporation
WUC	Water Utilities Corporation
ODA	British Overseas Development Assistance
PV	photovoltaic
SPSS-X	Statistical Package for the Social Sciences computer program

PREFACE

This report is based on work undertaken by Dr. John Gay at the Botswana Renewable Energy Technology (BRET) project from January 10, 1984, to April 30, 1985. Dr. Gay is a survey consultant for Associates in Rural Development, Inc. (ARD), the contractor which is implementing the BRET project for the U. S. Agency for International Development (AID) under contract number 633-0209-C-00-1024-00.

The research design and questionnaire for the Botswana urban domestic energy use and attitude survey were developed by Dr. Gay and BRET staff members with the assistance of numerous individuals from the government of Botswana (GOB) and private organizations. In particular, the study design was prepared in close collaboration with the Ministry of Mineral Resources and Water Affairs (MMRWA). The final version of the questionnaire incorporated the best ideas of many people, to whom Drs. Gay and Zietlow wish to express their appreciation. Thanks are also due to the many enumerators who worked long hours conducting the survey. Finally, special thanks go to Mr. Mike Parsons and Mr. Geoff Hinchcliffe of the Ministry of Finance's Computer Bureau for providing computer-assisted data analysis of the survey results.

1.0 EXECUTIVE SUMMARY

The Botswana Renewable Energy Technology (BRET) project was designed as a pilot project by the Government of Botswana (GOB), Ministry of Mineral Resources and Water Affairs (MMRWA), and the United States Agency for International Development (USAID). The project was designed to forward the energy policy goals of Botswana's Fifth National Development Plan (NDP-5). As defined in the project paper, its two purposes were:

- to introduce village renewable energy technologies (RETs), which are easily reproduced and inexpensive; and
- to research, develop and put into use RETs which can reduce Botswana's dependence on vulnerable supplies of increasingly expensive fossil fuels.

International economic development experiences have demonstrated repeatedly that successful programs in technology development and transfer must be demand driven not supply drive. Therefore, BRET project implementation required the conduct of a village energy-use and sociological needs assessment survey to help determine a range of appropriate RETs; technologies which would decrease the growing demand for fuelwood through increased availability of rural domestic RETs and awareness of conservation needs. RETs would focus on improved use of or substitution for wood; technologies derived from locally available resources that are cheap, abundant and can save labor and money.

In order to meet these project purposes, the following development and dissemination process was designed to be used for each technology:

- needs and resource assessment;
- technology identification and selection;
- prototype development and testing;
- technology demonstration and installation;
- operation and maintenance or comprehensive field testing; and
- national or widespread dissemination.

The survey research reported herein addressed the need for base data which could provide the project implementation with the ability to assess energy resource and technology development needs of the people of Botswana and provide information to BRET and MMRWA, which could be used for dissemination of RETs and development of national energy plans and strategies.

This survey is part of the picture which also involves the BRET two-village survey and follow-up fuel measurement study and of the British Overseas Development Administration (ODA)-sponsored Rural Energy Study. All of these studies are part of the BRET and MMRWA master planning processes.

In late 1983, the terms of reference (see Appendix A) for the town domestic energy study were completed, six sites selected, and the social researcher consultant identified. This study was to look at only domestic energy use and not commercial or industrial energy use. This is the report of a survey completed in three towns and three major villages in 1984. The total sample of households surveyed was 576, which included 128 in Gaborone, 64 in Palapye and 96 in each Selebi-Phikwe, Lobatse, Serowe and Molepolole. Data were collected during three different seasons of the year: the hot summer, the fall transition and the cold winter. During the months of February, April and June, enumerators made three sets of three consecutive-day visits to the households. Fuel measurements were taken which provided the amounts of energy used on two consecutive days, three times during the year. Each day, questions were asked concerning:

- household demographic characteristics;
- household infrastructure;
- overall household economy;
- energy-source energy-use equivalents per household per year;
- fuel sources by amount and task; and
- attitudes toward energy requirements and fuel use.

The households sampled in each community were intended to be roughly proportional to the population size thereof, but to ensure a good representation of the diverse households in each community, a slightly larger proportion was chosen in the smaller centers. The survey sample is comparable to the household sample of the National 1981 Census, with the exception that this survey included more households in the upper end of the income scale. This was a conscious decision made to adequately capture the diversity of energy use and demand across all income sectors of the economy. Definitions used in stratifying the sample population can be found in section 4.0.

There has been an enormous amount of demographic, infrastructure, attitude and energy data collected. They have been coded and entered into the mainframe computer in the GOB Computer Bureau. These data are accessible to other interested parties for additional analysis. Because of the limited scope of this study, there is considerable analysis which could still be done. The

data have been analyzed by the Statistical Package for the Social Sciences (SPSS-X) program and are available in a form for immediate use with this sophisticated statistical analysis program.

The results of this survey have reinforced several important concepts which are held to be universally applicable in the economics and sociology disciplines when considering the process of national economic development:

- in the process of national economic development as family household income increases, there is an accompanying shift in consumer preference toward higher-value goods and services; and

- household investment decisions regarding the adoption of new, improved technology are strongly modified by the relationship of available disposable income and individual perceptions of the presence of risk and uncertainty.

The importance of understanding the constraints and opportunities presented by the validation of these two socioeconomic concepts for prioritizing the RET-applied research and dissemination activities of the BRET program should be kept firmly in mind.

Analysis of the survey data across five income strata within the sample have demonstrated that as income increases, Batswana households consume more aggregate energy per capita and on a daily basis. The increased energy consumption has two characteristics of importance to the technology development activities of BRET. First, the increased energy consumption occurs in a shift to higher-value (more expensive and nonrenewable) energy sources as well as an increase in the gross consumption of a range of energy sources. Second, the increase in available disposable income manifests itself in the consumption of a wider range of energy-using household appliances and systems. The data have shown a fairly clear progression of household energy use, ranging from a reliance on one principal fuel to provide energy for one or two primary energy-using activities with the lowest-income households, to a dependence on a majority of the available energy sources to provide energy to many household activities within the higher-income households. The implications of these facts for BRET are in the area of opportunities for the development of a wide range of energy-saving technologies which can conserve fuels by increasing the efficiency of their use in the lower-income households, and which can substitute renewable energy sources for conventional fossil fuel consumption while increasing the efficiency of energy use in the higher-income households.

Examination of attitudinal data collected during the survey combined with the BRET experiences with technology transfer in Ditshegwane and Shoshong prior to the survey have strongly reinforced the concept of risk avoidance in relation to new

technology adoption among lower-income households. This situation is especially true for the lowest-income households responding to the survey questions. Families whose available disposable income is marginal and insecure have demonstrated almost complete aversion to suggested changes in not only the technologies which use energy for basic household operations (cooking and heating water), but also to changes in the systems of fuel acquisition. The implications of this information for BRET are in the area of constraints to the development of new technologies which use available fuels more efficiently for families within the lowest-income households. Development of these new technologies should proceed on a modest scale within the BRET program; however, the major emphasis will have to be placed on the development of appropriate dissemination strategies which rely less on a formal process of transfer and more on the information diffusion process, which occurs naturally within society.

There is also a measure of reluctance to accept change among the highest-income households responding to the survey. It will be important for BRET to understand the nature and scope of these attitudes in targeting the energy sources and technologies powered by these sources, which they hope to modify and perhaps replace.

Recognition of these constraints is, at the same time, a recognition of opportunities for BRET technology development. The attitudinal data have clearly demonstrated the interest in and ability to change among the larger segment of Batswana society and across the widest range of fuels and technologies. Among those households surveyed in this study, only 20.5 percent were classified as the lowest- and highest-income groups, leaving a target group of about 80 percent of the population. This is not to say that households falling into the two income extremes should be ignored by BRET program activities, but is to say that interventions planned for these two groups should be selective and that the largest area of opportunity across the widest spectrum of energy use will be with households not belonging to the income fringe in Batswana society.

Within the opportunities set, analysis of the survey data have provided information which should be of use to BRET in its effort to prioritize subsequent applied research, technology development and dissemination activities in the realm of renewable energy. Probably the most important finding is that cooking is the largest energy-consuming activity of households across income strata in Botswana, followed by water heating. Seasonal variation of energy consumption is not significant. Technology development should clearly focus on these two activities, in that they account for over 70 percent of household energy use.

Among the sample households, those using wood as their principal cooking fuel range from a surprising 24 percent in Gaborone to 86 percent in Palapye, with a mean number of households across the six communities of 56 percent. Gas-using households (as principal

cooking fuel) rank second, in terms of numbers ranging from 50 percent in Gaborone to 13 percent in Palapye, with a mean of 39 percent. These figures strongly indicate that among the five principal fuels in Botswana (wood, paraffin, coal, gas and electricity), wood and gas deserve special attention in BRET planning.

In terms of attitudinal data, the most important set of responses seems to indicate that for the majority of households, energy in itself is not viewed as a problem. Rather, the cost of energy supplies is a very important problem. This response indicates a lack of education regarding the relationship between the total available supply of energy and the cost of that energy, i.e., the economics of supply and demand. The vast majority of respondents noted that the cost of fuels, regardless of type, had increased in the recent past. The only reason for such cost escalation, in the absence of artificially imposed government price support, is relative scarcity. While it is possible to argue that gross aggregate supplies of domestic energy and or stability of imported supplies in foreign markets, such as the Republic of South Africa, may be such that aggregate supply apparently meets or exceeds aggregate demand for energy, this is not indicative of how fuel prices are set in the domestic marketplace of the cost to consumers.

The fact that the majority of people do not recognize that fuels of all varieties are scarce in Botswana does not auger well for successfully or, perhaps, easily instilling a conservation mentality in the population. This indicates that for BRET, as well as the government institutions responsible for energy supply, that there is a requirement to build into technology development and dissemination programs a series of information programs designed to raise the issue of energy scarcity and the need for conservation of energy with the population. There is a clear relationship between the adoption of energy-saving technology and long-term cost saving. This message should be passed on to the population before a widely successful renewable energy technology development and dissemination program can be achieved.

Related to this public perception of energy supply is an overwhelming response to a series of questions regarding responsibility for resolution of energy-supply problems. While the majority of those responding indicated that regulation of unbridled cutting of trees for fuel should occur, the seat of responsibility was clearly seen to be with larger authority organizations, such as tribal councils or central government ministries. Most respondents did not recognize the connection between individual conservation efforts and resolution of energy-supply problems at the national level, whereas they did have the opinion that top-down problem resolution would be the most effective action. While the issue of national fuelwood management is not one which BRET will be asked to deal with, the importance of these commonly held attitudes toward the role of individual action in relation to energy conservation should be addressed by BRET in

connection with their dissemination efforts.

Finally, with respect to public awareness of RETs in general, the survey results indicate a general level of awareness of specific technologies, such as the solar water heater. However, there was a general lack of appreciation for the significance of the RET. The majority of respondents indicated that while they were aware of the physical technology, they did not think of it in terms of the energy source being used to power it, nor the implications of its use for longer-term financial savings to the individual and positive contribution to national energy supply objectives. For BRET program development, it appears that this level of knowledge will be important to the continuing acceptance of RETs within Botswana.

Respondents were asked to indicate their interest in and willingness to purchase and/or make and use various RETs. Of course, attitudinal data of this sort can only be taken as indicative of what people may or may not do. Perceptions about the advantages and disadvantages of different types of stoves and cooking devices were similar across income strata. Generally, there was strong interest in the improved metal stove, given an increase in fuel efficiency of at least 10 percent. Respondents were mixed regarding the retained heat cooker, with a mean of 45 percent willing to purchase one and 65 percent willing to make one. However, there was a deviation of 50 percent between the lowest- and highest-income groups, with the latter more willing to buy one. With regard to the mud stove, fuel savings had to be significantly higher (40 to 50 percent) than the current level to persuade the majority of respondents to switch to the use of a mud stove over the currently used open fireplace. Solar hot water would be of interest to households with water service, with certain caveats placed on affordability of the system. Finally, regarding photovoltaic (PV) domestic electricity, there was a significant interest displayed among the middle- and higher-income respondents in mini-systems designed to provide a limited amount of electricity to power certain essential appliances in the household.

In conclusion, the analysis of the survey data strongly indicates that RET development programs will require two conditions to be met for technology adoption by the target group. First, the new technology must be appropriate to household needs and compatible with existing household systems. Second, the new technology must be affordable to the target group and able to demonstrate sufficient return on investment over a reasonable payback period.

The report is organized in three main sections. The introduction provides a background context for the survey. The survey methodology is presented according to sampling method, staff training and questionnaire enumeration and data analysis. Research findings are presented according to a general discussion of energy use and demand, attitudes and perceptions of fuel use, a

specific discussion of consumption and uses of five major fuels and an overview of household energy-using technologies. Appendix A contains the terms of reference for the study. Appendix B contains the survey questionnaire.

2.0 INTRODUCTION

The Botswana Renewable Energy Technology (BRET) project was designed as a pilot project by the Government of Botswana, Ministry of Mineral Resources and Water Affairs (MMRWA), and the United States Agency for International Development (USAID). The project was designed to forward the energy policy goals of Botswana's Fifth National Development Plan (NDP-5). As defined in the project paper, its two purposes were:

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- to research, develop and put into use RETs which can reduce Botswana's dependence on vulnerable supplies of increasingly expensive fossil fuels.

Project implementation required the conduct of a village energy-use and sociological needs assessment survey to help determine a range of appropriate RETs; technologies which would decrease the growing demand for fuelwood through increased availability of rural domestic RETs and awareness of conservation needs. RETs would focus on improved use of or substitution for wood; technologies derived from locally available resources that are cheap, abundant and can save labor and money.

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The survey research reported herein addresses the need for base data which could provide the project implementation with the ability to assess energy resource and technology development needs of the people of Botswana and provide information to BRET and MMRWA which could be used for dissemination of RETs and development of national energy plans and strategies.

BRET's first survey activity took place in the two pilot villages of Ditshegwane and Shoshong and results have helped the project staff to:

- determine primary energy needs and end uses, which suggested technology options for selection and development;

- determine sociocultural and economic design parameters for technologies;

- identify individuals, organizations and institutions that could play major roles in the technology development process; and

- identify individuals and groups that could facilitate or hinder the dissemination process.

The first two-village survey provided the basis for the initial technical direction for rural domestic RETs and decisions to focus attention on cooking devices, simple solar water heaters and improved building techniques. BRET developed prototype earthen stoves and prototype and production models of a sheet-metal stove and a double-pillow model retained-heat cooker. Development and dissemination of these two devices continued at the time of this survey.

There are two different categories of villages in Botswana, based on size:

- small villages with populations between 300 and 4,500 people; and

- major villages with populations between 4,500 and 35,000 people.

There are several smaller settlements in Botswana with populations less than 300 as well as six towns. Towns have autonomous local government structures comparable to those at the district level, while several villages comprise an administrative district.

The largest population concentrations are the most significant contributors to firewood depletion and imported fuels use. BRET was interested to know what application there could be for the rural domestic RETs in these larger population concentrations. MMRWA was interested in gathering information related to energy use for a future energy master plan. The ODA was to sponsor a nationwide rural village energy use and fuelwood availability study. BRET and MMRWA agreed to proceed with this "urban survey." Consequently, the towns and largest major villages were the logical location for this study. MMRWA coordinated efforts between the "urban" and rural studies.

In the planning and implementation of this survey, the term "urban" has been used to identify this study, which was initially to be implemented in towns only. Later, it was decided to include several major villages that were seats of both district and tribal administration and/or on the rail line. When one uses the sociological definition of urban, which involves the cash and commercial economy, formal organizations and institutions, employer-employee

relationships, etc., rather than the traditional barter economy and informal structure of farmers and herders, then there is some application of the term urban to these major villages. To be more precise, this survey involves the study of domestic energy use and attitudes in three towns and three major villages in Botswana.

By the end of 1983, the terms of reference (see Appendix A) for the town domestic energy study were completed, six sites selected, and the social researcher consultant identified. This study was to look at only domestic energy use and not commercial or industrial energy use. This is the report of a survey completed in three towns and three major villages in 1984. The total sample of households surveyed was 576, which included 128 in Gaborone, 64 in Palapye and 96 in each Selebi-Phikwe, Lobatse, Serowe and Molepolole. Data were collected during three different seasons of the year: the hot summer, the fall transition and the cold winter. During the months of February, April and June, enumerators made three sets of three consecutive-day visits to the households. Fuel measurements were taken which provided the amounts of energy used on two consecutive days three times during the year. Each day, questions were asked concerning:

- household demographic characteristics;
- household infrastructure;
- overall household economy;
- energy-source, energy-use equivalents per household per year;
- fuel sources by amount and task; and
- attitudes toward energy requirements and fuel use.

There has been an enormous amount of demographic, infrastructure, attitude and energy data collected. They have been coded and entered into the mainframe computer in the GOB Computer Bureau. These data are accessible to other interested parties for additional analysis. Because of the limited scope of this study, there is considerable analysis which could still be done. The data have been analyzed by the Statistical Package for the Social Sciences (SPSS-X) program and are available in a form for immediate use with this sophisticated statistical analysis program. The lists of data and program files are available from BRET and MMRWA.

3.0 RESEARCH METHODOLOGY

3.1 The Survey Design

This study involved the collection of secondary and primary data of both a quantitative and qualitative nature regarding patterns, sources and technologies of energy use in "urban" Botswana. A stratified sample survey was developed to provide the framework for primary data collection. The criteria for selection were developed on the basis of extensive consultation with BRET and MMRWA. The initial plan had been to confine the survey to two or three centers, but as the project design became better defined, there was reason to include a wider sample. In the end, it was decided to include a total of six towns and major villages to take into account, as much as possible, the variation within eastern Botswana.

The first question to be resolved concerned the choice of the specific towns and villages. Representativeness, ease of access and freedom from competing surveys were the major criteria which were used to select communities. It was decided from the start to keep the survey within the eastern, relatively more populous portion of the country. This excluded such centers as Ghanzi, Maun and Kasane. On the other hand, these northern and western villages represent only a minority of Botswana's population. Moreover, they are not as seriously short of firewood as the major eastern towns and villages.

The second decision was to choose three each of the major villages and towns in the eastern corridor. There are six towns altogether in the area, of which we chose three, omitting Jwaneng, Orapa and Francistown. It was decided that Selebi-Phikwe could represent the mining towns and that nothing new would be learned in Francistown that could not be learned in Gaborone and Lobatse. Thus, the towns included were Selebi-Phikwe, Gaborone and Lobatse.

There are more major villages than towns, but here, too, it was decided that three would represent the whole. Molepolole was chosen as a large village from a dry area on the edge of the Kalahari, Palapye as a village on the main road, and Serowe as a major political center which is the largest of all the Tswana villages. In the process, communities, such as Kanye, Mochudi and Mahalapye were omitted, as they were not sufficiently different to justify adding them to the sample. Originally, Mahalapye was to be included, but in the end, it was omitted in favor of Lobatse, both because the former offered more variety as a town and several concurrent surveys were already underway in Mahalapye.

Within each village or town, moreover, it was necessary to select a sufficiently large sample of households to achieve the greatest diversity of Tswana society. A strictly random sample within any community would not have explored this diversity

sufficiently to allow generalizations. As a result, the decision was to select a stratified group of households, with more emphasis on the high-income households as their use patterns are more diverse than those of low-income households. Specifically, each enumerator was to choose 32 households, of whom 15 were to be low income, 12 middle income and five high income.

Enumerators used housing descriptions and job categories to select an appropriate strata population. The 15 lower-income households were to be selected from squatter housing, informal-sector work sites, servants' quarters, site-and-service housing and other evidently low-income housing. The 12 middle-income families were to be chosen from civil servant housing, company housing and other middle-income houses or areas. The five high-income households were to be chosen from senior government officials, senior tribal officials, foreign aid personnel, expatriate or local business executives and other high-income households. The inclusion of foreign aid personnel may be questionable, considering their transient status in Botswana society. However, they do represent a segment of the highest-income energy consumers.

Also interviewed were sellers of fuel and energy-using devices. The choice of fuel and device sellers was left to the enumerators and was to depend on the particular community. In the case of the towns, enumerators were to try to choose a representative sample of dealers, while in the villages they were asked to interview all the dealers they could find, if possible. The hope was that the enumerators would approach the sellers on an informal basis in order to learn as much as they could about their businesses. In the end, this part of the survey did not produce data of the same quality as the household survey.

In addition to interviews, the enumerators were asked to make observations of fuelwood areas used by the people of the community. They were given a list of questions, with instructions to answer them in as much detail as possible. They were not expected to provide quantitative answers suitable for computer analysis, but rather to give qualitative impressions of the areas they observed.

A member of the BRET staff accompanied each enumerator as he/she made the initial selection of households to ensure that the selection met the standards set by the project. Clearly, the application of the criteria varied according to the particular community because of intercommunity variations in income and, thus, variations in the consumption of energy and energy-using technologies.

It was decided to interview people in the three basic seasons of the year--summer, winter and the transition period which, in this case, is autumn. In each season, households in the sample were to be interviewed on three successive days in order to understand in detail the pattern of energy use. At each interview, the amount of each fuel and water present in the household was

recorded as well as the way in which fuel and water were used in the preceding 24 hours. In this way, energy and water use for a 48-hour period in each season would be available for analysis. In addition to the questions on energy and water supply and use, each of the nine interviews in the household was to include a different set of questions on social structure, economics, knowledge and attitudes. The questions were ordered in such a way that the interviews, in effect, amounted to a short course in energy use and renewable energy technology. The initial interview explored the person's knowledge of energy-using devices, both traditional and innovative, and also made an inventory of devices used in the household. The second and third interviews asked for information on members of the family and household structures. In the autumn, the first interview asked about water supply and toilets as well as agriculture and livestock.

The second interview asked about types and uses of trees and, in the case of wood-burning households, where and with what utensils people cooked. The third interview considered types of fuel and firewood known by the household and the advantages and disadvantages of each. In the winter, people were first asked about their fuel use pattern in the past and present. In the second interview, they were asked about their evaluation of and preference for particular fuels and devices. In the final interview, they were asked to agree or disagree with statements concerning energy use, rank their life problems, state what they learned by participating in the survey and what they would suggest for the BRET project.

Several problems were experienced in the course of implementing the survey, which relate directly to the ability to measure. Ordinary bathroom scales were used to weight wood, coal and gas bottles. Every effort was made to weigh fuels several times and to treat the scales with care, but the scales fluctuated in their reporting of the same weights. The analysis was done on the difference in weight from one day to the next, and each enumerator used the same scale throughout, so it is hoped that the measurements have overall statistical validity. It is recommended that accurate, robust instruments be used, even though they will be more expensive. Access to electricity and/or water meters was limited. The meters were often locked and keys unavailable at the time of the interview. As a result, several quantities were reported as unknown. Presumably, more accurate data could be obtained from Botswana Power Corporation (BPC) and/or Water Utilities Corporation (WUC). Water and paraffin were measured by the litre, using a standard beaker for small quantities. The enumerators taught how to estimate the proportion of water or paraffin if these were only part full.

3.2. Staff Selection and Training

A field supervisor was first selected with responsibility for ensuring the quality of the field data, performing observations

in the communities, and ensuring that the questionnaires were properly coded for computerization. The enumerators were selected from a large group of students who had just completed their Form 5 examinations and were waiting for the results. A total of 70 students were interviewed and tested, and 18 of them were chosen. Staff training was conducted in Gaborone at the BRET office and the University of Botswana.

There were three main parts in the training: instruction in energy technology, practice in weighing and measuring, and lectures and test interviews in using the questionnaire. Instruction in energy technology involved learning the basic concepts of fuel use and the new technologies developed by BRET. Weighing and measuring required the enumerators to weigh solid fuels, measure liquid quantities and read electricity and water meters. Using the questionnaire meant going over it in detail in lectures and then carrying out complete interviews in sample households in Gaborone.

After training, each group of enumerators was taken to its town or village by a member of the BRET staff. This person established contact with local officials, on the basis of initial contacts made by the BRET Extension Support Supervisor before the training period began. This person also assisted the enumerators to choose the first set of households in order to make sure they were using the correct methods. High-income households were chosen by direct approach to influential members of the community. Middle-income households were chosen by going to institutions and government departments and companies as well as by finding persons living in comfortable but not high-income houses. Low-income households were found by selecting representative housing areas and then choosing households on a systematically random basis.

The enumerators were then left to begin the first round of interviews, which occupied most of February and the beginning of March. They were instructed to choose four households for the first three days of the week, and complete the first round of interviews for these households; then choose an additional four households for the second three days of the week. In this way, they were to complete the 32 households in four weeks. Their work was checked regularly by the Field Supervisor. At the end of the first round of interviews, the enumerators returned to Gaborone to code the questionnaires for the computer. The Field Supervisor provided oversight and completed code assignments. During that time, enumerators also received further training in the use of the questionnaire before returning to the community for the second round of data collection.

After returning to the village or town, enumerators spent a week collecting background data on fuel and energy-device sellers and wood-collecting areas, before starting on the second round. The second round occupied most of April and the early part of May. Enumerators then returned to Gaborone for data coding and further

instruction. They again returned to the community at the end of May for further collection of background data and later, in June, for the third round. After completing the third round, they returned to Gaborone for final data coding. On completion of coding, some enumerators and two additional university students remained to check the coded data to eliminate as many errors as possible.

3.3 Data Analysis

The final stage of the project was data analysis. The first step was to check the data for errors in coding and entry. This turned out to be a very time-consuming and difficult process. Not only were there more than 60,000 lines of data, but the coding and entry were not as careful and thorough as they might have been. Because of the many errors, and before the analysis could be done, many obviously fallacious entries (such as, 10,000 kg of charcoal used by a family in a village which had probably never seen that much charcoal in all its history) had to be eliminated. Many of the errors were clearly the result of misplaced decimal points, but others were probably the result of inaccurate data collection.

After the data were "cleaned," they were analyzed at the Computer Bureau of the Ministry of Finance, using the latest version of the SPSS-X. Three major sources of additional information were used in analyzing the data. The first was a listing of megajoule equivalents of basic fuels, and provided by a recent World Bank study of energy use in Botswana. The second was the 1981 census, which provided important baseline data for the six communities by which to ground the survey in hard community data. The third was a survey of the informal sector in Maun, Francistown, Selebi-Phikwe and Mochudi, conducted by the Ministry of Local Government and Lands (MLGL) in 1983, which provided useful information on wood sellers.

4.0 RESEARCH FINDINGS

The presentation of the survey research findings is organized by a general discussion of urban energy use and demand among the survey sample, followed by the presentation of responses which elaborate on attitudes and perceptions about fuel use among respondents. Then a presentation of survey responses regarding the use of the five major fuels is followed by a discussion of household energy-using technologies.

The survey sample involved 576 households which included 128 in Gaborone, 64 in Palapye and 96 in each of Selebi-Phikwe, Lobatse, Serowe and Molepolole. There were an average of 5.5 members per household, of whom 1.6 were employed. The households sampled in each community were intended to be roughly proportional to the population size thereof, but to ensure a good representation of the diverse households in each community, a slightly larger proportion was chosen in the smaller centers. The survey sample is comparable to the household sample of the National 1981 Census, with the exception that this survey included more households in the upper end of the income scale. This was a conscious decision made in order to adequately capture the diversity of energy use and demand across all income sectors of the economy. This decision was based on two conclusions:

- Results of the two-village survey coupled with the knowledge of BRET project staff of town life had shown that there is much greater similarity in energy use and demand among lower-income families in Botswana than among higher-income families; and

- theories of micro-economics have told us that as incomes rise, disposable income increases with commensurate changes in consumption, which reflect changes in preference for higher value goods/services and a greater proportion of conspicuous consumption reflected in household expenditures--both of which involve higher energy use in terms of direct and embodied energy.

Given that the primary purpose of this survey of urban energy use is to assist BRET project staff in prioritizing their research, development and dissemination activities in order to correspond with the needs of the people of Botswana and assist the GOB in developing energy policies and plans to facilitate meeting these needs in the future, the rationale for obtaining a somewhat larger sample from the higher-income groups--who theoretically consume higher-value energy in greater quantities--is clear.

It will be important to note the definitions used in stratifying the sample population. In Botswana, as in other societies, earned household income is not a fully adequate indicator of total available, disposable income due to the presence of other relatively liquid assets held by the household. In Botswana, cattle are held

as not only a status indicator of wealth, but also are used as liquid assets when household investment or expenditure needs exceed available cash resources. For this reason, it was decided that while household income is a rather tidy means of stratification, this measure alone would not sufficiently capture the purchasing power of the households in the sample. It was decided, too, that the total value, expressed in replacement cost terms, of energy-using technologies present in each household will adequately reflect the "real" level of disposable income by household. Thus, for the purposes of this analysis, the "income" strata are defined as:

- Very low-income households have no member of the household reporting more than 50 pula per month in income and not more than two members reporting less than 50 pula per month, and the total value of energy-using devices in the household have a replacement cost of less than 75 pula;

- low-income households have not more than one member reporting more than 300 pula per month or two members each reporting not more than 200 pula per month, and the total value of energy-using devices have a replacement cost of less than 350 pula;

- middle-income households do not report more than 1,000 pula per month, regardless of the number of income earners, and the total value of energy-using devices have a replacement cost of less than 4,000 pula;

- high-income households have one or more members reporting more than 1,000 pula per month income, or the total value of energy-using devices in the household have a replacement cost of more than 4,000 pula; and

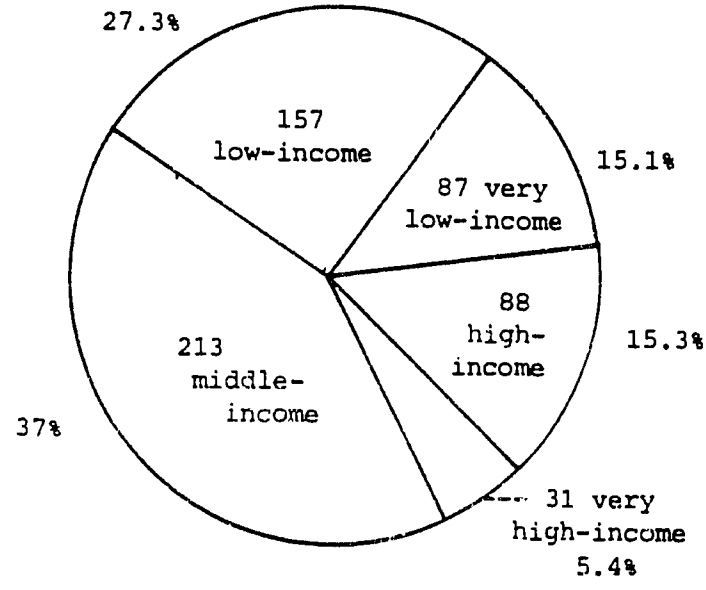
- very high-income households have one or more members reporting more than 1,000 pula per month and the total value of energy-using devices have a replacement cost of more than 4,000 pula.

Figure A shows the relative distribution of households in each of these five strata within this sample.

In fact, survey results strongly support the postulated correlation between income and energy/energy technology consumption. Fuel use in Botswana is closely related to household disposable income. Survey data show that higher-income families consume more expensive, higher-value and convenient fuels, such as gas and electricity (and related technologies), while the lower-income families rely primarily on wood and paraffin and related technologies.

Figure A

Relative Distribution of Sample Households by Income Strata



4.1 Urban Energy Use and Demand

For this discussion, megajoules provide a convenient common unit of reference, as each of the major fuels has a megajoule equivalent. These equivalents are provided in Table 1 and have been taken from World Bank estimates for Lesotho.

Table 1

Megajoule Equivalents of Basic Fuels

Fuel	Unit	Megajoules
wood	kilogram	14.6
paraffin	litre	35.0
coal	kilogram	23.4
gas	kilogram	45.1
electricity	kilowatt-hour	3.6
petrol	litre	32.4
diesel	litre	35.9

There are different possible estimates for wood and coal, depending on the type and moisture level of the fuel. The estimates used herein are based on conditions in Botswana and, therefore, should be useful for the present report, even though they are not necessarily the same as figures used in other surveys.

Table 2 gives the total megajoules used per household per day by households in the six communities by income group. The totals are somewhat low because of missing cases for electricity use. Survey enumerators were often unable to read electricity meters because they were locked and keys were unavailable. Electricity is used primarily by the upper-income households, and thus some upward adjustment is needed for these. Based on information supplied by the BPC, this study estimates that an upper-income family uses up to a maximum of about 50 kWh a day and perhaps as little as 15 kWh per day in summer, assuming no air conditioning is used. Poorer households, with only perhaps five light connections and no other use of grid-supplied electricity, would use only about 1 kWh per day.

Table 2

Megajoules Used per Day by Community

Income Strata	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	Sample Mean
very low	100.8	90.6	91.1	80.3	57.8	95.8	81.3
low	54.8	158.0	90.2	108.1	71.2	108.9	98.9
middle	67.3	120.3	94.0	91.2	95.6	132.7	100.3
high	93.9	200.1	236.8	141.4	137.4	196.3	162.1
very high	108.8	158.2	198.0	216.0	145.4	303.1	161.3
Column means	75.4	134.4	137.2	109.0	91.7	138.9	111.2

The averages obtained in our survey for high-income households and very high-income households are 2.9 and 4.2 kWh per day, respectively, which are clearly too low. Thus, it is probably necessary to add about 15 kWh per day to these figures, or about 50 MJ per day to the figures for the high- and very high-income households, and perhaps 5 kWh per day, or about 18 MJ, to the middle-level income households. The figures given in Table 2, however, reflect the actual data and not the amendments suggested in this paragraph.

There are differences among the six communities, with the three northern centers tending to use more megajoules per day than the three southern centers. This may be a function of a greater scarcity of wood in the south than in the north. On the other hand, it may be due to different measurement techniques used by the different enumerators.

More striking are the consistent increases in energy used per day with an increase in income. The higher-income families have relatively more energy-using devices and relatively higher disposable income and, thus, use more energy. The pattern levels off with the high-income and very high-income groups, with each using an average of 160 MJ per day. With the addition of the missing electricity data, the totals would reach about 210 MJ per day. In some communities, notably Selebi-Phikwe, Lobatse, Serowe and Palapye, higher-income households seem to be using substantially more than others, particularly the remarkable 303.1 MJ per day reported by the very high-income households in Palapye.

It is striking that the figure is so much lower in Gaborone than in any of the other centers. It is likely that this is related to the low use of wood in Gaborone, a fact to be discussed in detail later. It is easier to be economical with gas or electricity than it is with wood, particularly when the wood is plentiful; but when it is scarce, then there must be recourse to more economical alternatives.

Cooking as Principal Fuel Use

In the exploration of household infrastructure, a wide spread of energy-using devices was found. Many of the lower-income households in the villages have only open fires for cooking and candles for lighting, while higher-income families in the major towns have a range of energy-using devices, as might be expected. Regardless of the specific energy-using technology in each household used for cooking, this activity was found to be the largest single use of energy across strata. Given the predominance of cooking among all household energy uses, Table 3 presents the percent of households in the sample using one of the five major fuels as the primary cooking fuel by town. The table also includes figures derived from the 1981 National Census for the reader to use as comparison statistics. This is useful in that the slightly disproportionate number of high-income households in this sample causes wood and paraffin users to be under represented in all communities, while electricity and gas use is over-represented.

Table 4 shows the percent of income groups using each of the five principal cooking fuels. These data demonstrate the strong correlation between income and principal cooking fuel.

Wood is the most commonly used. Half of the middle-income families use wood, while only a quarter of the high-income families use it as their principal cooking fuel. Of the high-income families who use wood as their principal cooking fuel, 90 percent live in villages and only 10 percent in towns. Paraffin is the second most important fuel for low-income households. Of the low- and very low-income families for whom paraffin is the principal cooking fuel, 93.5 percent live in towns and only 6.5 in villages. Low-income families in villages are able to hunt for firewood, but that option is not available in the towns. Coal as a principal

Table 3

Principal Fuel for Household Cooking

Principal Fuel	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	Mean
wood-sample	24.0	64.8	34.4	75.0	70.0	85.9	55.6
wood-census	26.9	79.2	35.2	90.7	91.8	90.2	54.1
daily MJ use	91.4	147.5	133.0	120.3	82.2	134.8	118.3
paraffin-sample	15.2	3.3	21.5	2.2	1.0	---	8.0
paraffin census	36.7	3.4	40.6	3.4	3.5	3.5	22.6
daily MJ use	32.8	36.5	23.8	12.8	11.0	---	27.5
coal-sample	---	---	7.5	---	---	---	1.2
coal-census	0.5	0.2	5.8	---	0.1	1.0	1.0
daily MJ use	---	---	196.4	---	---	---	196.4
gas-sample	50.4	15.4	31.2	20.7	29.2	12.5	28.7
gas-census	24.1	5.2	15.1	5.5	4.1	5.0	14.6
daily MJ use	74.7	114.1	180.4	69.2	118.1	179.1	108.6
electric-sample	10.4	16.5	5.4	2.2	---	1.6	6.4
electric-census	11.8	11.9	3.0	0.4	0.4	0.3	7.6
daily MJ use	96.3	126.6	187.1	227.3	---	97.2	125.4

Table 4

Principal Cooking Fuels

Income Strata	Fuel: Wood	Paraffin	Coal	Gas	Electricity
very low	82.7%	14.7%	0.0%	2.7%	0.0%
low	70.5%	13.5%	0.6%	14.1%	1.3%
middle	52.4%	6.1%	1.9%	32.1%	7.5%
high	25.3%	0.0%	1.1%	63.2%	10.3%
very high	22.6%	0.0%	3.2%	45.2%	29.0%
sample means	55.6%	8.0%	1.2%	28.7%	6.4%

fuel is confined to Lobatse, and there it is primarily the middle-income people using it. Altogether, 57.1 percent of the coal users are in the middle group. Gas is used by a small minority of the low-income families. Of this group, 75 percent are in towns and only 25 in villages. Much more commonly, gas is used by the middle- and high-income groups. Almost two-thirds of the high-income group and slightly less than half of the very high-income group use gas as their principal fuel. Finally, electricity is used mostly by the two highest income groups for cooking, whereas only

a few low- and middle-income households use electricity as their principal cooking fuel. In summary, household income is a strong indicator of what fuel people use for cooking, even though it is not a perfect predictor. A few low-income households use the more costly fuels and a few high-income households use wood, but the dominant pattern is otherwise.

General Energy Use

Table 3 also gives the megajoules used per day, according to income group and by principal fuel used for cooking. In this case, the results for gas users should probably be raised by about 30 MJ per day and for electricity users by about 70 MJ per day, to take into account the missing electricity information.

Clearly, the fuel with which people are able to be most economical is paraffin. If wood is plentiful, then it is easy to use an armful on one large fire, whereas a bottle of paraffin is used with caution.

Table 5 is based on the percent of a household's total fuel uses. It lists the percent of households whose use of each fuel falls into the deciles 0-9.9%, 10-19.9%, and so on up to 100%. Half of the households report that 80 percent or more of their fuel uses are of wood, a fact which further stresses the importance of fuelwood to Batswana families. Almost a quarter of the respondents report that 80 percent or more of their fuel uses are of gas.

Table 5

Household Fuel Use

Percent	Wood	Paraffin	Coal	Gas	Electricity	Other
0 - 9.9	37.6	87.9	98.4	66.0	90.4	97.5
10 - 19.9	1.4	1.4	---	0.7	1.4	0.7
20 - 29.9	1.6	1.8	---	1.2	1.1	1.4
30 - 39.9	2.8	0.5	0.4	2.5	0.4	---
40 - 49.9	1.2	0.2	0.5	1.1	0.5	---
50 - 59.9	0.9	1.2	0.4	1.4	0.4	---
60 - 69.9	1.8	1.2	---	2.1	0.2	---
70 - 79.9	2.7	0.4	0.2	2.5	0.5	---
80 - 89.9	2.8	0.5	0.2	2.7	0.2	---
90 - 99.9	9.9	0.5	---	6.0	0.7	---
100	37.2	4.3	---	13.8	4.3	---

Only about five percent of the households use either paraffin or electricity at or above the 80 percent level. The coal users all rely on other fuels as a supplement, presumably for lighting and casual cooking. Other fuels include primarily petrol or diesel for transport, and candles and batteries for lighting and small electrical appliances. A very small number of families, mostly

from Molepolole, reported using other cooking fuels, such as dung or crop residues, but these are so few that they do not justify further discussion.

Table 6 lists amounts of fuel used per day of the principal heating and cooking fuels. Electricity is omitted for the reason that so many cases were missing due to locked meter boxes. The totals are weighted according to the proportions given in Table 2.

Table 6

Principal Cooking Fuel Use

	wood kg	paraffin litres	coal kg	gas kg
wood users	6.50	0.14	0.01	0.10
paraffin users	0.67	0.31	----	0.04
coal users	1.74	0.09	2.87	1.87
gas users	0.72	0.09	0.01	1.29
electric users	0.85	----	0.03	0.20
weighted average	3.86	0.16	0.04	0.31

There are a total of 42,386 households in the six surveyed communities and, therefore, it can be estimated that 163.6 metric tons of fuelwood are being used in these towns and villages daily, as well as 6,781.8 litres of paraffin, 1,695.4 kg of coal, and 13,140 kg of bottled gas.

One surprising result is that gas consumption is greater among coal users than among those whose principal cooking fuel is gas. This may be an error, or it may show that coal users like to have a standby gas cooker, which they use when they don't want to start up a coal stove. Coal users also use a substantial amount of wood, probably to start the fire in the stove.

Public Attitudes and Awareness of Energy Use and Demand

A certain amount of subjective-attitudinal data were collected during the survey, which yield information about the general level of awareness of energy-related problems in Batswana households across strata. A series of questions were asked of each survey respondent regarding self-perceived life problems. Responses indicate a general level of awareness of an energy problem--fuel shortages. However, fuel shortages concerned people in all income strata at a relatively low level in relation to other major socioeconomic problems they faced. Fuel shortages across all types of fuel were regarded as a major problem by approximately 30 percent

of the middle-income Batswana, while a mean 15.5 percent of the very low- and low-income Batswana responded positively, with none of the very high-income households reporting this as a problem. When asked to respond to a statement regarding energy as a household problem, the majority reaction across income strata indicated a mild awareness that energy was a problem, although there was a higher tendency for women to be more concerned about the problem than men.

In responding to questions regarding fuel-saving technologies, very low-income respondents suggested that these technologies would be beyond their financial reach, while the very high-income group indicated that technologies which save fuel should be within the financial capability of even the poorest Batswana. Generally, however, most respondents indicated some degree of concern for the cost of energy-saving devices.

When asked to respond to a perceived need for national planning to address the fuel shortage in advance of a time when such a shortage would become critical in Botswana, it was not surprising that higher-income groups responded strongly positive, while lower-income groups were neutral. In terms of the cumulative effect of individual actions regarding fuel conservation, lower-income households believed that only government can solve the problem while upper-income groups believed that there would be a positive cumulative effect upon national energy conservation efforts as the result of individual actions.

In relation to specific energy problems which respondents were asked to elaborate on, the main and overriding issue was that of fuel shortages and the related escalation of fuel costs over the recent past. Lower-income households were concerned with the shortage of fuelwood and paraffin, middle-income groups were more concerned with the shortage of gas, and high-income families were interested in improving the regularity of supplies available for purchase on the local market.

4.2 Attitudes and Perceptions about Fuel Use

As part of the survey, respondents were asked to comment on fuel use and availability in relation to subjective indicators of energy-related problems. The fuel most often unavailable has been paraffin, reported in 39.4 percent of the responses given by members of the sample. Paraffin is followed by gas (12.6 percent), petrol (11.8 percent), coal (6.3 percent), wood (5.5 percent), electricity (2.4 percent) and diesel (1.6 percent). The absence of paraffin is mentioned most often by the very low-, low- and middle-income groups and not at all by the very high-income group. The shortage of gas, petrol and electricity, on the other hand, was the concern of the high- and very high-income groups. It is striking that wood is so low on the list. The reason is that it probably never actually disappears from the market. More

likely, it either increases in price or is more difficult and time-consuming to gather when there is a shortage.

These problems have mostly taken place within the last few years, with 11.5 percent saying the problem was in 1984, 9.8 percent in 1983, and 3.5 percent in 1982. Similarly, fuel shortages have occurred mostly in the 1980s. In general, people are about equally divided about the success they have had in solving their fuel problems. Altogether, 33.9 percent said they had had poor success, 23.4 percent fair success, and 42.7 good success. In Lobatse and Serowe, people reported the least success in solving energy problems. Table 7 lists the worst fuel problems that people in each income group could remember:

Table 7

Worst Fuel Problems

Problem	Very Low	Low	Middle	High	Very High	Mean
no paraffin	26.7	29.6	18.1	11.4	10.5	20.4
no firewood	13.3	8.5	10.3	11.4	5.3	10.0
no gas	----	1.4	12.1	16.2	10.5	8.9
no transport	6.7	1.4	3.4	6.8	21.1	5.0
no money to buy	10.0	2.8	3.4	4.5	----	3.9
irregular supply	----	1.4	3.4	----	15.8	2.9
explosion/fire	5.3	2.8	2.6	----	5.3	2.5
nothing	36.7	50.7	44.8	47.7	31.6	44.3

Respondents were asked to comment on what changes in fuel use they had seen since their childhood and what changes they had seen in the last two years in order to find the shifting pattern of fuel- and energy-use over the years. Table 8 lists the major changes, according to different income groups.

The big differences related to wood and wood use. In the old days, wood was the only available fuel, with the occasional exception of paraffin. Wood was plentiful, free of charge and easy to find. A greater variety of fuels is available today, a fact less often noticed by the very low-income groups than by others.

Table 9 lists the changes which people have noticed in the past two years. Three themes emerge in contrast to two years ago:

- the increase in prices,
- the shortage of wood, and
- the diversity of fuels.

Table 8

Changes in Fuel Use since Childhood

	Very Low	Low	Middle	High	Very High	Mean
more fuels used now	14.9	30.2	25.2	20.0	33.3	24.9
plenty of wood then	25.5	17.0	21.3	21.5	12.3	20.2
fuels expensive now	17.0	15.1	15.5	16.9	4.2	15.1
wood used then	12.8	9.4	10.3	13.8	16.7	11.3
only wood then	19.1	9.4	6.5	9.2	16.7	9.8
wood free then	14.9	9.4	11.0	6.2	----	9.6
no gas then	8.5	9.4	8.4	9.2	----	8.3
wood easy to find then	14.9	6.6	4.5	3.1	8.3	6.3
fuel demand now high	4.3	5.7	7.1	1.5	12.5	4.0
wood & paraffin then	4.3	5.7	1.9	3.1	12.5	4.0
nothing	6.4	4.7	18.1	15.4	----	11.6

Table 9

Changes in Fuel Use in Past Two Years

	Very Low	Low	Middle	High	Very High	Mean
fuel expensive now	30.0	23.1	24.4	34.8	23.8	26.3
wood scarce now	22.5	14.8	11.0	10.6	4.8	12.8
more fuels used now	10.0	14.8	7.9	13.6	14.3	11.3
demand now high	12.5	6.5	12.2	6.1	9.5	9.5
more gas used now	2.5	8.3	6.1	7.6	14.3	7.0
more wood used then	7.5	11.1	5.5	3.0	9.5	7.0
nothing	32.5	33.3	47.6	25.8	28.6	37.6
don't know	7.5	9.3	10.4	24.2	5.8	11.8

The very low-income group notices the scarcity of wood more than others, while the very high-income group notices the diversity of fuels, notably the increase in gas use. The scarcity of wood is most noticed in Palapye and Molepolole, the increase in prices in Serowe and Lobatse, the high demand in Selebi-Phikwe, and the increased use of gas in Gaborone.

Enumerators asked about the magnitude of the price rise over the last two years. Almost everyone agreed that the price had risen, but the actual amounts are too rough to give in tabular form. The mean price rise is about 20 percent in that time period, which roughly corresponds to the general increase in the cost of living during the same period.

In particular, people were asked why it had become necessary to pay for fuelwood, which formerly had been free for the taking.

The main reason, given in 46.2 percent of the cases, is that wood is now scarce. The second reason (12.8 percent) is that villages are now too big for easy gathering. Third (12.5 percent) is that people have started selling wood on a commercial basis. Fourth (10.5 percent) is the fact that those who are engaged in wage employment cannot spare the time to go long distances to gather wood. Those who use wood as their principal cooking fuel give the most reasons and, in particular, put most stress on wood being scarce today.

All survey respondents were asked to rank the major fuels in order of preference. The fuel most often mentioned, as well as the most preferred fuel, is wood. This is followed by gas, which is mentioned by slightly fewer people, probably because it is not available to lower-income people. Paraffin is mentioned by more people, but is at a lower level of preference. Electricity is at the same level of preference as paraffin, but mentioned by fewer people. Coal is last both as regards numbers and level of preference. Interviews about the reasons why people like certain fuels and not others were open ended. Table 10 gives the advantages of the principal fuels and the percent of the sample stating each advantage.

Table 10

Advantages of Fuels

Fuel Type	Cheap	Many Uses	Easy to Use	Quick to Use	Easy to Get	Lasts Long	Much Heat	Replaces Fuels
wood	57.0	9.5	10.0	0.5	16.1	3.8	9.7	1.5
paraffin	45.3	20.1	7.6	7.0	3.8	12.2	0.6	10.8
coal	34.5	8.0	2.3	1.1	10.3	17.2	33.3	----
gas	19.2	2.4	27.6	46.8	2.0	14.8	1.6	0.8
electricity	5.0	11.3	46.1	31.9	9.9	1.4	3.5	0.7

Table 11

Disadvantages of Fuels

Fuel Type	Danger-ous	Expen-sive	Smelly Dirty	Scarce	Lasts Short	Hard Work	May Run Out
wood	2.6	14.8	17.9	35.8	2.8	13.8	1.0
paraffin	33.7	25.6	32.3	2.3	7.3	0.9	1.2
coal	16.1	4.6	72.4	10.3	---	16.1	1.1
gas	53.6	34.8	4.0	2.0	0.4	----	9.2
electricity	23.4	77.3	1.4	3.5	0.7	0.7	0.7

Table 11 lists the disadvantages of the principal fuels, and the same pattern is evident in both tables. People like wood, paraffin and coal because they are cheap, and gas and electricity because they are easy and quick to use. The tradeoff is obvious. Wood is the only fuel that is not considered to be dangerous by a substantial segment of the sample. The main disadvantage of wood is that it is scarce, with dirt being a second disadvantage. The main disadvantage of coal is that it is dirty. Paraffin is dangerous, dirty and expensive. The principal disadvantages of gas and electricity are that they are dangerous and expensive, with gas having a third disadvantage--there is no fuel gauge by which to tell when the supply is almost finished. Even though there are great coal resources in Botswana, there is apparently no great interest in using coal for domestic purposes.

These advantages and disadvantages explain in large measure why certain fuels are used by certain population groups and not others. In particular, the odds are loaded against the use of coal, which seems to the people who were interviewed to have few real advantages and many disadvantages in relation to the other fuels. It will require a substantial campaign of public education, a change in coal-using technology and a reduction in price to persuade people to use coal, if and when Botswana's coal mines come into full production.

4.3 The Five Major Fuels

Wood

We have seen in Table 6 that wood is the most widely used fuel in the six villages and towns in the sample. Not only do half the sample use wood for 80 percent or more of their fuel uses, but households using other fuels as their major cooking fuels also use wood for at least some purpose. Only in 37.6 percent of the households does wood use fall below 10 percent of all fuel uses. Table 12 gives the wood burned per household by community and income group.

Table 12

Kg of Wood Burned per Household per Day

Income Strata	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	Mean
very low	3.6	6.2	3.1	5.8	3.5	6.1	4.6
low	2.3	8.9	3.8	7.0	4.5	6.5	5.5
middle	1.3	4.2	3.5	3.8	3.6	6.5	3.7
high	0.7	1.6	0.7	6.4	4.2	3.8	2.4
very high	---	0.8	0.7	8.3	7.7	---	2.8
mean	1.5	5.6	2.6	5.7	4.0	5.8	4.0

The pattern of wood use is very similar in the three villages of Serowe, Palapye and Molepolole among all strata. Given our hypothesized correlation between disposable income and preference for higher-value fuels, it is striking that the highest levels of wood use in Serowe and Molepolole are by the very high-income families. On the other hand, the highest income households in the three towns of Gaborone, Selebi-Phikwe and Lobatse scarcely use any wood. They are firmly tied into a modern way of life, with gas and electricity as their main fuels. In the southern towns, moreover, even the low-income groups don't use much wood, a situation similar to but more extreme than that in Molepolole, which is at the western edge of the fertile eastern belt and is short of wood.

There is less difference between the consumption levels of the households whose principal fuel is wood than there is between the consumption levels of the different income groups. Wood users in the three northern centers--Serowe, Palapye and Selebi-Phikwe--use respectively 7.4 kg, 6.8 kg and 8.0 kg per day, while the wood users in the southern centers--Molepolole, Gaborone and Lobatse--use 5.1 kg, 5.0 kg and 5.6 kg per day. The mean for the north is 7.4 kg per day and for the south is 5.2 kg per day. The southern amount is probably enough to do the basic cooking for the household, as it equates to megajoules of heat. The northern amount represents a more generous use of fuels in a relatively more wood-abundant region.

Looking at the per capita use of wood, Serowe, with 2.15 kg of wood per day per family member for wood-using families, consumes little more wood than Gaborone, with 1.11 kg per day per family member, or Lobatse, with 1.17 kg per day per family member. The extremes of per capita daily use are Selebi-Phikwe, with 1.97 kg per day per family member, and Molepolole, with 0.86 kg per day per family member. It should be remembered, however, that Selebi-Phikwe is a relatively new town, with fuelwood still nearer to the center of population, while Molepolole is both an old village and on the fringes of the desert.

There is a smooth gradation from very low to very high incomes if we consider per capita consumption of wood. The very low-income families, who depend almost entirely on wood, use 1.30 kg of wood per day per family member, the low-income group, 1.07 kg; the middle, 0.70; the high, 0.59 and the very high, 0.35. The difference between low- and high-income families in Serowe and Molepolole is much less than elsewhere. The very high-income families in these two centers use .98 kg of wood per day per family member, somewhat less than their low-income counterparts, who use 1.16 and 1.08 kg, respectively.

Non-wood-using households, of course, use much less wood per day per family member than the wood-using households. The overall mean for the wood-using households is 1.34 kg per day per family member, while the overall mean for the non-wood-using households

is only .15 kg per day per family member. This difference is significant at far beyond the .001 level. Another significant difference is that between male-headed and female-headed households. The male-headed households use only a mean of .7 kg per day per family member. This is in part due to the fact that female-headed households are in general a lower-income group and, thus, more dependent on wood than the male-headed households.

People were asked whether they had bought wood and, if so, how much they paid for it. Unfortunately, the actual price data are not useful. The figures are much too high and suggest that the question was sometimes, though not always, asked in such a way as to elicit the price paid for the most recent purchase, however large it might have been or however long ago. Hence, these data cannot be used. On the other hand, it is possible to learn something from the fact that the household has at some time bought wood. Of the wood-using households, it is reported that 71.1 percent had bought wood at some time. In general, the percent of wood-using households in each of the six communities is higher than the percent of those who at some time have bought wood. The differences are largest in the three villages of Serowe, Palapye and Molepolole, and smallest in Gaborone and Lobatse, where it is very difficult to gather wood in the nearby open countryside.

Altogether, 82.8 percent of wood uses were for cooking or making tea, and another 15.3 percent were for heating water for washing, bathing or beer brewing. It is not surprising that there were essentially no other uses for wood as a fuel. Only the lowest-income households use wood to light the house at night. Most fuelwood comes from trees which grow wild, usually at cattle posts or on uncultivated land. The varieties of trees which provide fuelwood are well known to persons who must depend on them. People were asked to state what types of fuelwood they know and what advantages each type has. Table 13 lists the most commonly known types of trees and their advantages as fuelwood. More trees than these were named, but for ease of reading the table, we have eliminated those mentioned by fewer than 10 percent of the respondents. In each case, the Setswana and botanical names are used as none of the common fuelwood trees have common English names.

The principal advantages that people attribute to a type of fuelwood are that it burns hot, there is enough of it available and it burns well. Only Moselesele is noteworthy for the fact that it is easy to chop, presumably an important consideration to the old and infirm people with small incomes who are dependent on wood. There are some differences of opinion about wood between the entire sample and people who use wood as their primary cooking fuel. Among the latter, the most important advantage for fuelwood is that it burns hot, mentioned by 45.0 percent of the respondents. This is followed by the preference that there is plenty of it (26.6 percent), it burns well (24.4 percent), it is easy to ignite (11.0 percent), it is easy to chop (7.5 percent) and it is common locally (4.9 percent).

In particular, 10.6 percent said the Motswere is hard to chop, 4.8 percent said that it produces too much ash and 4.1 percent said the trees are scarce. Of Moselesele, 8.0 percent said that it is scarce and 7.4 percent that it burns quickly. Mosu is said by 7.8 percent to produce too much smoke and by 5.3 percent that it burns too quickly. Honudiri is said by 3.5 percent that it produces too much ash, Mongaga by 3.4 percent that it burns too quickly, and Mogonono by 7.2 percent that it burns too quickly. The other comments were made by fewer than 3 percent of the persons interviewed.

Table 13

Firewood Types and Advantages

	Named by Sample	Burns Very Hot	Plen-tiful	Burns Well	Easy to Ignite	Easy to Chop	Common Locally	Less Smoke
Motswere (Combretum imberbe)	42.9	17.8	13.6	11.0	1.8	---	0.4	0.7
Moselesele (Dichrostachys cinerea)	36.7	12.7	3.5	6.7	3.2	9.0	1.2	0.9
Mosu (A. tortilis, A. nilotica)	31.1	12.7	3.9	6.5	3.2	1.9	2.3	0.4
Mophane (Colophospermum mopane)	31.1	11.8	15.7	5.7	2.8	1.8	0.4	0.7
Mohudiri (Combretum apiculatum)	26.9	9.9	5.3	7.4	1.2	1.2	0.7	0.4
Mongana (A. mellifera)	25.6	11.8	2.3	5.8	3.5	0.4	0.9	0.5
Mogonono (Teminalia sericea)	21.6	6.4	2.7	1.6	1.9	1.2	3.2	0.2
Mokoba (A. nigrescens)	18.0	4.9	4.6	5.1	1.2	0.2	0.5	0.5
Moloto (A. erubescens)	14.8	5.1	3.5	2.8	1.6	0.5	0.5	---
Motlopi (Boscia albitrunca)	13.3	3.0	1.2	2.1	---	0.5	0.5	---
Mogotlho (A. erioloba)	12.0	3.7	1.2	1.4	1.9	0.5	0.9	---

People sampled were also asked what type of tree they owr and in what numbers. Trees mentioned by less than 2 percent of the sample are not included in Table 14, which gives the percent of household in each community having each type of tree, as well as the overall mean number of trees owned by those households.

Table 14

Households Owning Trees

	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	% of Sample	Mean Number
Mulberry	9.4	27.2	11.6	11.0	13.5	26.6	15.3	2.6
Hedge	16.4	28.3	11.6	13.2	4.2	14.1	14.7	20.6
Motsetse (Euphorbia tirucalli)	0.8	2.2	1.1	47.3	3.1	50.0	14.5	3.0
Peach	7.8	19.6	27.4	9.8	9.4	3.1	13.1	2.5
Morula (Sclerocarya caffra)	7.0	23.9	----	18.7	7.3	9.4	10.8	1.8
Mosalaose	3.9	----	6.3	16.5	19.8	14.1	9.5	2.8
Eucalyptus	2.3	8.7	7.4	6.6	6.3	2.1	8.5	3.8
Acacia	8.6	3.3	4.2	8.8	10.4	12.5	7.8	2.0
Jacaranda	5.5	10.9	9.5	5.5	7.3	4.7	7.2	1.9
Orange	3.9	8.4	7.4	6.3	3.1	4.7	5.7	1.8
Papaya	3.1	14.1	---	8.8	---	9.4	5.5	3.2
Banana	2.3	18.5	3.2	7.7	---	1.6	5.5	4.7
Mogonono	4.7	----	1.1	---	15.6	10.9	5.1	3.8
Mopane	0.8	29.3	---	---	---	---	4.9	2.2
Moroja (Azanza garckeana)	2.3	9.8	1.1	12.1	2.1	---	4.6	1.1
Grape	3.9	5.4	4.6	4.4	2.1	1.6	4.6	1.9
Fig	3.1	6.5	2.1	11.6	---	3.1	4.4	1.6
Motswere	3.1	1.1	---	2.2	5.2	12.5	3.5	2.1
Guava	1.6	8.7	2.1	5.5	---	4.7	3.5	2.1
Mango	4.7	5.4	---	4.4	---	1.6	2.8	1.7
Moloto	9.4	3.3	---	---	---	---	2.7	1.1
Mohudiri	5.5	4.3	2.3	1.1	1.0	---	2.3	1.6
Pine	---	5.4	1.1	2.2	3.1	1.6	2.1	2.5

Almost all of the trees owned by families are at their homes, rather than in their gardens or at their fields. Only in Molepolole did 22 percent of the households report having trees at their fields. Altogether, 93.4 percent of the trees were reported to be located at home, 2.5 percent in the garden, 3.8 percent at the lands and 0.4 percent at the cattle posts. Table 15 shows the household uses of trees which people plant on their own land.

The biggest uses of trees are for shade, fruit for the family, fencing, windbreaks and flowers. Use of wood for fuel appears far down on the list. While energy is not perceived to be a major problem facing most households for primary wood-using families, fuelwood shortages and cost increases are perceived as problems. The majority of survey respondents indicated a need for regulation of tree cutting. The major exception to stricter control of cutting

was with households using fuelwood as their principal cooking fuel. Across all communities surveyed, respondents felt that government should be responsible for regulating cutting. When asked to suggest a preferred method of such regulation, approximately 30 percent indicated that they did not know how to accomplish this type of control over the use of communal land tree resources. The most common positive suggestions are that wood be rationed or permits be issued to those who wish to enter the area to cut wood. A substantial group, particularly in Molepolole, urged that unrestricted gathering of wood continue. Another approach is to control the times when the forest is open for cutting. These schemes would obviously be very difficult to administer, unless there were supervisors on duty, which would itself be difficult owing to the large area of communal land where wood can be collected.

Table 15

Uses of Trees

	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	Mean
shade	56.2	39.0	20.2	40.3	60.6	47.5	44.5
fruit	23.0	48.9	58.5	34.3	15.9	22.3	34.3
fencing	11.2	10.6	12.3	20.8	6.8	28.3	15.1
windbreak	7.9	1.9	2.1	2.3	15.2	16.5	6.7
flowers	3.4	10.2	3.2	4.6	6.8	0.7	5.5
fuelwood	5.6	2.3	5.3	---	0.8	---	5.5
sale of fruit	---	0.4	2.1	---	---	---	0.3
sale of fuel	---	1.1	---	---	---	---	0.1

Survey respondents indicated that they travelled between seven and 33 kilometers round trip to gather wood. The closest distance represents the average distance travelled for families in Selebi-Phikwe, presumably because it is a relatively new town. The farthest distances reported were for residents of Gaborone.

In most cases, these fuelwood areas are in remote places, far from the main motor roads. Often they are on communal lands, but in some cases they are on land which is part of a cattle post or lands area. In these cases, it is necessary to pay for use of the area. Enumerators reported that in some cases the owner of the area would demand 5.00 pula for a load of wood, or at least require the person to get permission for taking it. In theory, fuelwood cutters are not supposed to cut live trees, but in fact, according to the enumerators, this rule is often violated. In some cases, wood collectors are supposed to come from particular villages only, and "intruders" from Gaborone or other distant towns are the object of resentment.

Enumerators also asked to interview wood sellers themselves. They found that those who sell wood in their homes travel an average of 12.7 kilometers to obtain wood, while those who move around the village to sell their wood travel an average of 17.7 kilometers to obtain it. Of the entire group of sellers interviewed, 43.2 percent transport their wood by donkey cart, 20.5 percent by pick-up truck, 18.2 percent by headload, 11.4 percent by lorry, 4.5 percent by ox cart and 2.3 percent by car. In 78.7 percent of the cases, they get their wood from state or communal lands, in 19.1 percent from other people's lands and 2.1 percent by scavenging. In more than half the cases, they say that people buy wood from them because it is the least expensive fuel.

More information can be obtained from a study of the informal sector in Botswana, conducted by the Applied Research Unit of MLGL in 1983.

If wood is scarce and increasingly expensive, then it is necessary for people to find ways to use the little wood they have more economically and efficiently. Table 16 lists by community the percent of suggestions respondents offered as to means of saving fuelwood in the home.

Table 16

Ways to Save Fuelwood

	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	Mean
use coal	15.6	29.4	35.1	1.7	1.3	25.5	17.2
use less to cook	20.0	26.5	17.5	3.4	6.6	7.8	14.2
put fire out	8.9	10.3	3.5	5.2	28.9	13.7	12.2
use other fuel	21.1	5.9	5.3	17.2	---	21.6	11.7
use wonder box	15.6	39.7	---	1.7	3.9	---	11.2
efficient stove	---	---	---	29.3	21.1	---	8.2
cut wood small	5.6	5.9	5.3	5.1	9.2	3.9	6.0
use new device	---	---	---	3.4	---	7.8	2.5
cook less often	1.1	---	1.8	8.6	---	5.9	2.5
use cow dung	4.4	1.5	---	---	---	2.0	1.5
cook indoors	---	---	---	---	3.9	---	0.7
impossible	16.7	11.8	12.3	6.9	18.4	17.6	14.2
don't know	4.4	4.4	36.8	20.7	10.5	2.0	12.2

These ways to save fuelwood suggest new and changed technologies. This report will discuss such technologies in Section 6.0. The very low-income groups have the least knowledge of how to save fuelwood. Their main suggestion was to put the fire out after finishing cooking. The implication is that in many households, particularly those with outdoor fireplaces, the fire is simply

allowed to burn itself out after the meal is prepared. Those whose principal cooking fuel is wood echo this suggestion. In general, people agreed strongly, at the level of 3.8 percent, with the statement, "cooking with a stove, not an open fire, saves time and money" and disagreed at the level of 2.2 percent with the statement, "the best way to cook is on an open fire." The very low-income households agreed least with the first statement, being almost neutral in comparison with the other four groups, and likewise disagreed only mildly with the second statement.

Paraffin

Paraffin is much less used than wood. As stated, it is an occasional fuel for most people, often used when a quick meal or cup of tea is desired. Table 17 gives the amounts of paraffin used per household by community and income group.

Table 17

Litres per Day of Paraffin Used per Household

Income Strata	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	Mean
very low	.20	.00	.27	.04	.09	.21	.1
low	.19	.11	.10	.07	.12	.11	.12
middle	.18	.04	.11	.05	.28	.26	.16
high	.01	.00	.14	.06	.35	.04	.09
very high	.00	.00	.00	.14	.14	.00	.04
mean	.13	.05	.13	.06	.22	.17	.13

There is not much variation between the different communities. Molepolole families use the most paraffin, at about 220 millilitres daily, while those in Selebi-Phikwe use the least, about 50 millilitres daily. The high level of paraffin use in Molepolole is probably related to the relatively low level of wood use, as that is a village where gas and electricity are not as readily available as in Gaborone or Lobatse. The high- and very high-income families use the least paraffin. As indicated earlier, they are tied to the use of gas and electricity. On the other hand, the very low- and low-income groups also use less than the middle-income group, as they rely mainly on wood.

Even those who use paraffin as their principal cooking fuel do not use much. The daily average is 310 millilitres of paraffin, with the Gaborone figure highest, at 400 millilitres daily. Those who cook with wood use an average of 140 millilitres daily, and those who cook with gas or coal use 90 millilitres daily. The biggest consumption of paraffin for the wood and gas users is in

Molepolole, where both groups average 220 millilitres of paraffin a day, probably due to the scarcity of wood and occasional difficulty in getting gas bottles filled. Those who cook mostly with electricity do not report any paraffin use at all. There is much more uniformity if daily paraffin use is considered on a per capita basis. From this view, the very low-income groups use 37 millilitres per person per day, the low use 29, the middle 32 and the high-income households use 24 millilitres, while the very high-income families use only 5 millilitres daily, on the average. Those who cook with paraffin use 93 millilitres daily per capita, while those who rely mainly on another cooking fuel use only 24 millilitres per person per day.

As in the case of wood, female-headed households tend to use more paraffin per capita, namely 37 millilitres daily, than male-headed households, who use only 25 millilitres daily. It must be remembered, however, that the female-headed households tend to be smaller and have lower incomes and are, thus, more likely to be dependent on paraffin. Even among the very low- and low-income households, having a large family implies that there is someone available to collect fuelwood. In the low-income, small families, people often must depend on paraffin alone, particularly in the towns.

The principal use of paraffin is for cooking and heating water, which makes up 58.3 percent of all the possible uses. Next is lighting, with 39.7 percent of the uses. The total amount of paraffin used for cooking, on the other hand, would be much more than that used for lighting, as the small hurricane lamps (which make up the majority of all paraffin-using lamps) use fuel much more economically than larger Aladdin lamps or pressure lamps.

Coal

As noted, coal is used in Lobatse and scarcely anywhere else in the country. The mean coal use per day in Lobatse is 0.3 kg per household, an amount which is the same for low-, middle- and high-income families. The very low-income groups do not use coal, and the very high-income families use 0.9 kg per household per day. Those who depend on coal as a cooking fuel use 2.9 kg per household per day; those who cook with wood or gas use 0.1 kg per household per day; and those who cook with electricity use 0.2 kg per household per day. Paraffin users do not use coal at all, further supporting the argument that people who depend on paraffin to cook are generally small and marginal households.

Per capita use of coal displays a similar pattern. Those who cook with coal use 0.7 kg per person per day, while households which cook with other fuels use less than 0.1 kg per person per day. The low-, middle- and high-income families use 0.1 kg daily per person, while the very high-income group uses 0.3 kg daily per person.

More than 92 percent of the uses of coal are to cook and heat water. A few households, 3.2 percent, reported that they use coal for manufacturing goods. Unfortunately, this aspect of coal use was not pursued during this survey. Enumerators asked an open-ended question about what might lead people to use coal. Table 18 lists the conditions under which respondents from different economic strata might use coal.

Table 18

Households Willing to Use Coal

	Very Low	Low	Middle	High	Very High	Mean
coal stove available	25.5	38.5	29.3	20.9	16.0	28.8
during the winter	25.5	22.9	25.0	23.9	36.0	25.1
if cheaper than wood	14.9	7.3	6.4	10.4	8.0	8.5
if not dangerous	2.1	4.2	6.4	14.9	12.0	7.2
if cheaper than gas	4.3	---	4.3	9.0	4.0	4.0
if available free	2.1	3.1	5.7	1.5	---	3.5
if taught its use	8.5	1.0	2.1	---	---	2.1
cheaper than electric	---	1.0	0.7	4.5	8.0	1.9
if easy to ignite	4.3	2.1	1.4	1.5	---	1.9
cheaper than paraffin	2.1	3.1	0.7	---	4.0	1.6
would never use coal	19.1	18.7	21.4	22.4	24.0	20.8

The most important precondition for using coal is that coal stoves be available. For obvious reasons, people prefer coal stoves in winter than summer. Otherwise, the main reasons have to do with the price of coal relative to other fuels. There are few significant differences between the strata. On the other hand, there are strong differences between those who already use coal as their main cooking fuel and other users of other types of fuel. Coal users assert that coal is cheaper than wood or gas. More than half of the paraffin users, 51.9 percent, say they would use coal if a stove were available, while 28.1 percent of wood users, 25.7 of gas users and 18.2 percent of electricity users give that argument.

There is an obvious and strong relation between the willingness to use coal and its price relative to the household's present fuel. If the price were only half the price of the present fuel, a large majority, including electricity users, say they would switch to coal. On the other hand, if coal remains more expensive than other fuels, people see no benefit in shifting to it. The low- and middle-income families are in general more willing to shift to coal than the high- and very high-income families.

Gas

Gas is the second most widely used fuel among the households

interviewed during this survey, with only wood being more commonly used. Table 19 gives the amount of gas used per household by community and income group on a daily basis.

Table 19

Kg per Day of Gas Used per Household

Income Strata	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	Mean
very low	.00	.00	.44	.00	.00	.00	.07
low	.27	.10	.10	.03	.03	.25	.15
middle	.53	.31	.51	.46	.53	.31	.44
high	.67	.32	1.82	.75	.69	1.50	1.08
very high	.79	1.08	1.98	.87	.78	5.33	1.19
mean	.47	.25	.85	.60	.38	.60	.46

There is a steady increase in the amount of gas used per household per day from the very low- to the very high-income households. The very low- and low-income groups used almost no gas, both because they depend on wood and gas bottles and stoves are expensive. Gas use in Lobatse is lower than in the other centers, perhaps because middle- and high-income respondents there depend more on coal than on gas. Those households which use gas as their principal cooking fuel use an average of 1.29 kg daily, with a high of 3.33 kg in Palapye and 0.86 kg in Gaborone. The Palapye figure seems unusually high and may reflect a great degree of conspicuous consumption by very high-income households, who average 5.33 kg per day, as shown in Table 19.

Per capita use of gas ranges from 0.01 kg per day for the very low-income households, 0.05 kg for the low-income group and 0.14 kg for the middle-income to 0.31 for both the high- and very high-income households. As mentioned, the high- and very high-income families in Palapye use more gas per person per day than families in any of the other communities surveyed. As in the case of other fuels, gas is used basically for cooking and heating. A small percent of households also use it for cooling, freezing and lighting.

Electricity

The pattern of electricity use is quite different from that of the other fuels. It is an all-purpose source of power and, hence, is used for more than cooking and heating water. Altogether, 46.4 percent of its uses are for cooking, 11.6 percent for heating water, 8.8 percent for cooling and freezing, 13 percent for entertainment, 2.1 percent for pressing clothes and 17 percent for lighting.

Table 20 lists the kilowatt-hours of electricity used per household by community and by strata. These figures must be taken in relative terms only, because, as stated, in many cases the electricity use was not recorded as the meter boxes were locked. Unfortunately, it is not possible to tell which households these were and, as a result, the figures are generally too low. On the other hand, it is possible to identify trends and relative proportions from these figures.

Table 20

KWH of Electricity per Household

Income Strata	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	Mean
very low	.00	.00	.00	.00	.00	.00	.00
low	.19	.62	.00	.00	.00	.00	.17
middle	2.24	2.06	.80	.25	.21	.01	.98
high	5.46	4.55	1.09	.78	.35	2.61	2.89
very high	6.55	3.67	6.34	1.83	.00	2.00	4.24
mean	2.61	1.56	1.19	.31	.15	.55	1.14

The pattern is clear, even if the absolute numbers are too low. Electricity is used more by high- and very high-income families than by others and is much more used in towns than in villages. Those who use electricity as their main cooking fuel, of course, use the most electricity, 5.34 kWh per day. Gas users are next, with 2.04 kWh per day, coal users follow with 0.78 kWh per day, and wood users with 0.36 kWh per day. Those who cook with paraffin do not record any electricity use.

Per capita use of electricity shows the same pattern as household use. The overall mean is 0.29 kWh per capita per day, while very low-income groups use none, low-income groups use 0.03 kWh, middle income, 0.29 kWh, high-income, 0.68 kWh and very high-income, 1.10 kWh. Male-headed households also use much more electricity per capita than female-headed households, 0.39 kWh versus 0.06 kWh.

4.4 Household Energy-Using Devices

4.1.1 Devices in Use

Every household visited had some energy-using devices, even if only an open fire for cooking and lighting. The range of such devices was enormous, from the traditional and very low-income household with only an open fire to the very high-income, modern household with car, electric stove, refrigerator, television, stereo, and other luxuries. Table 21 lists the percent of house-

Table 21

Household Ownership of Energy-Using Devices

	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Molepolole	Palapye	Sample Mean	Mean Number	Mean Purchase Price
Fireplaces									
yard open fire	34.4	38.0	60.0	30.8	24.0	56.3	39.4	1.3	0
yard fireplace	---	2.2	17.9	18.7	47.9	3.1	14.8	1.9	0
house open fire	1.6	14.1	13.7	23.1	12.5	17.2	12.7	1.1	0
house fireplace	10.1	4.3	7.4	4.4	20.8	1.6	8.7	1.0	2
Stoves									
gas	47.7	21.8	53.7	27.4	41.7	26.6	37.8	1.1	172
paraffin	35.2	6.5	56.8	28.6	28.1	21.9	30.4	1.3	29
wood	14.1	22.8	13.7	26.4	10.4	32.8	18.9	1.1	286
electric	13.3	12.0	11.6	4.4	---	7.8	8.5	1.0	314
coal	1.6	---	18.9	---	---	---	3.5	1.0	126
Cooking Utensils									
kettle	41.9	5.4	58.9	4.4	69.8	9.4	33.6	1.3	20
toaster	11.7	3.3	9.5	---	5.2	1.6	5.8	1.0	24
mixer	10.9	5.4	2.1	---	6.3	3.1	4.6	1.4	47
roaster	5.5	1.1	5.3	---	2.1	---	2.7	1.0	25
elec. knife	4.7	---	---	---	---	---	1.3	1.0	--
hot plate	3.9	---	---	---	1.0	---	1.1	1.5	68
elec. pan	0.8	1.1	---	---	---	---	0.3	1.0	--
blender	0.8	---	---	---	---	---	0.2	1.0	--
food dryer	---	---	---	---	1.0	---	0.2	1.0	--
Coolers & Heaters									
refrigerator	43.8	21.7	41.1	18.7	11.5	21.9	27.7	1.1	594
fan	22.7	8.7	12.6	8.8	6.3	7.8	12.0	1.3	44
space heater	18.8	4.2	15.8	7.7	6.3	3.1	10.2	1.1	72
water heater	18.8	9.8	10.5	6.6	1.0	1.6	9.0	1.2	120
freezer	10.9	3.2	3.2	---	10.4	1.6	5.5	1.0	381
air conditioner	5.5	5.4	---	1.1	---	3.1	2.7	1.8	276
General Appliances									
iron	68.0	64.1	94.7	80.2	74.0	92.2	79.1	1.4	16
sewing machine	17.2	7.6	27.4	17.6	24.0	35.9	21.0	1.1	143
hair dryer	8.6	---	7.4	---	2.0	---	3.5	1.0	26
vacuum cleaner	5.5	2.2	2.1	2.2	1.0	1.6	2.7	2.3	179
knitting machine	2.3	2.2	2.1	1.1	2.0	1.6	1.9	1.0	247
clothes dryer	0.8	---	---	---	---	---	0.2	1.0	--
Office Equipment									
calculator	24.2	5.4	8.4	4.4	10.4	9.4	11.1	1.2	21
typewriter	7.8	2.2	7.4	---	4.2	4.7	4.7	1.0	128

Table 21 (continued)

Household Ownership of Energy-Using Devices

	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Molepolole	Palapye	Sample Mean	Mean Number	Mean Purchase Price
Tools									
saw	10.2	12.0	0.2	4.4	12.5	4.7	8.3	1.4	10
pump	0.8	15.2	8.4	11.0	3.1	12.5	7.8	1.2	103
lawnmower	6.3	2.1	1.1	1.1	1.0	1.6	2.7	1.1	168
generator	0.8	---	2.1	1.1	2.1	---	1.1	1.0	--
drill	2.3	---	3.2	1.1	---	1.6	0.9	1.5	80
mill	---	---	---	1.1	2.1	1.6	0.7	1.0	--
lathe	---	---	1.1	---	---	---	0.2	1.0	--
Lighting Equipment									
candle	67.2	43.5	83.2	46.2	66.7	42.2	60.8	3.1	--
hurricane lamp	38.3	28.3	51.6	38.5	52.1	60.9	44.6	1.7	6
torch	25.8	22.8	16.8	29.7	37.5	40.6	28.1	1.4	7
light bulb	39.8	28.3	31.6	16.5	7.3	15.6	24.6	9.1	--
Aladdin lamp	---	22.8	14.7	36.3	44.8	9.6	21.6	1.8	9
pressure lamp	2.3	6.5	9.5	8.8	13.5	4.7	7.6	2.7	24
fluorescent lamp	7.0	1.1	2.1	6.6	1.0	6.3	4.1	1.9	41
tin lamp	1.6	1.1	3.2	8.8	2.1	4.7	3.4	1.2	2
Communication/ Entertainment Devices									
radio	76.6	50.0	96.8	58.2	66.7	89.1	72.4	1.4	372
tape recorder	22.7	5.4	7.4	26.4	13.5	14.1	15.4	1.0	240
telephone	12.5	4.3	20.0	12.1	8.3	26.6	14.8	1.4	67
television	25.0	12.5	25.3	4.4	2.1	2.2	12.7	1.0	788
tape player	13.3	2.2	6.3	8.8	10.4	4.7	8.1	1.2	282
high-fi set	3.1	4.2	9.5	3.3	3.2	---	3.9	1.6	
phonograph	4.7	---	5.3	3.3	6.3	---	3.5	1.7	112
video player	3.1	13.0	---	1.1	1.0	1.6	3.4	1.1	1960
video recorder	7.8	1.1	2.1	2.2	1.1	---	2.8	1.1	948
slide projector	0.8	---	---	---	---	---	0.2	1.0	--
Means of Transport									
bicycle	23.4	30.4	21.1	27.5	12.5	17.2	22.3	1.3	196
saloon car	24.2	5.4	29.5	17.6	8.3	7.8	16.4	1.2	11512
pick-up truck	14.8	9.8	8.4	11.0	3.1	20.3	11.7	1.1	6636
lorry	3.1	9.7	10.5	9.9	5.2	3.1	6.4	1.4	12131
station wagon	6.3	2.2	1.1	4.4	3.1	3.1	3.5	1.2	9925
tractor	1.6	1.1	---	7.7	6.3	1.6	3.0	1.6	15701
motorcycle	0.8	2.2	2.1	1.1	1.0	1.6	1.4	1.0	1423

holds in each of the communities which own each type of device. The devices are grouped by category according to their general use. The mean number of devices of each type owned by the households which possess that type of device is given after the percent of the sample owning the device. The last number is the mean purchase price in pula of devices of that type. Dashes are listed where the price is not known.

The percent of households owning gas and paraffin stoves is higher than might be expected, given the level of use of gas and paraffin. However, it must be remembered that the paraffin stove is used primarily as an emergency stove for small cooking tasks and only in a few households as the main cooking device. Likewise, it can be expected that many households have gas stoves, although not all will use them. Gas bottles run out and people don't fill them, but leave them empty until some future date when there is a bit more money available.

Many households have open fires in the yard. This includes even some of the higher-income households, particularly when they are wood-using households. Kettles are the most common cooking device, which reflects the popularity of tea as a quick hot drink. Irons are extremely common in the households sampled. Altogether 54.5 percent are heated by wood or charcoal, another 28.2 percent use electricity, 8.2 percent are heated on a gas stove and 6.8 percent are heated on a paraffin stove. The great majority of irons, therefore, are very simple, flat irons, which must be heated externally before each use.

Most households use candles and hurricane lamps for lighting. There are a very few households using only the open fire, but they are increasingly rare. A quarter of the sample uses electric lights, 21.6 percent of the sample have Aladdin lamps and 7.6 percent have pressure lamps, all of which give bright light.

Approximately 75 percent of the sample respondents have radios, and it is likely that some of them have one without mentioning the fact, particularly in Gaborone and Selebi-Phikwe. Telephones, tape recorders and television sets are also quite common. A high proportion of the sample has some means of transport of its own, the most common being the 22.3 percent who have bicycles, the 16.4 percent who have ordinary cars and the 11.7 who have pick-up trucks.

Certain of these devices can be operated using several different energy sources. Table 22 lists the percents of the different fuels by which these devices are operated. Space heaters, water heaters, refrigerators and freezers are mostly run by electricity, even though alternatives do exist. Batteries are used to run electrical devices by households not connected to the grid. Radios are the most popular electricity user for people. Photographs, tape recorders and tape players are almost as popular. Most television users are connected to the grid. There are few current users of solar power.

Table 22

Sources of Energy for Household Devices

	Wood	Paraffin	Coal	Gas	Electric	Battery	Solar
stove	19.1	30.7	3.6	38.1	8.6	---	---
kettle	40.2	8.9	3.9	17.9	29.1	---	---
refrigerator	---	9.6	---	17.8	71.3	---	---
freezer	---	9.7	---	12.9	77.4	---	---
space heater	---	27.6	1.7	12.1	55.2	1.7	1.7
water heater	5.9	---	7.8	23.5	54.9	---	7.8
iron	54.5	6.8	1.1	8.2	28.2	0.2	---
pressure lamp	---	38.5	---	61.5	---	---	---
radio	---	---	---	---	18.9	81.1	---
tape recorder	---	---	---	---	33.7	66.3	---
tape player	---	---	---	---	33.3	66.7	---
television	---	---	---	---	87.5	12.5	---
phonograph	---	---	---	---	31.6	68.4	---

Table 23 contrasts the use of fuel with the use of hand power for those devices which can be operated by hand.

Table 23

Devices Operated by Hand or Fuel

	Hand	Battery	Electric	Petrol	Diesel	Wind
sewing machine	80.7	---	19.3	---	---	---
knitting machine	80.0	---	30.0	---	---	---
drill	57.1	---	42.9	---	---	---
saw	95.7	---	4.3	---	---	---
lawnmower	21.4	---	21.4	50.0	5.1	---
mill	25.0	---	---	---	50.0	25.0
pump	87.8	---	2.4	---	9.8	---
typewriter	69.2	11.5	19.2	---	---	---
calculator	1.3	93.3	5.0	---	---	---

In almost every case where hand power is possible, it is used. Hand calculators are an obvious exception. It is significant that no one reported using a solar-powered pump.

The very low-income group owns on the average only P10-worth of energy-using devices, the low-income group owns P93, the middle-income group, P672, the high-income group, P19,020, and the very high-income group, P29,695. The range is obviously extremely wide. Those for whom paraffin is the principal cooking fuel also own very little, with a mean of P171 worth. Wood users have a mean of P3,555, with an extremely large variance.

As indicated, wood users are drawn from the lowest- as well as the highest-income strata of Batswana. Coal users have a mean of P4,371-worth of devices, but with a smaller variance than that of the wood users, showing that coal users fall in the middle range of income strata. Gas and electricity users have P19,596- and P22,727-worth of devices, respectively--again, with smaller variances than that of the wood-using group.

4.4.2 Devices and Fuel Use

Households were asked how they had used energy and water during the two 24-hour periods in each of the three seasons. Table 24 lists the percent that each type of use accounts for among the total number of uses reported in the six communities.

Table 24

End-Uses of Energy and Water

	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	Mean
cooking	78.5	58.5	53.7	65.1	39.6	79.6	60.7
hot water	9.8	8.5	9.0	10.6	9.5	8.4	9.4
lighting	4.9	8.5	5.3	9.8	10.5	6.1	7.7
dish washing	1.4	7.6	5.4	2.3	13.3	1.1	5.8
bathing	1.1	3.3	2.9	2.0	11.2	2.8	4.2
entertainment	2.5	5.6	5.0	3.4	4.6	0.2	1.8
clothes wash	0.4	0.8	3.0	0.4	4.6	0.6	1.8
drinking	---	3.1	3.3	0.4	---	1.5	1.4
clean house	0.1	---	5.1	---	1.1	---	1.1
freezing	0.3	1.0	2.2	1.3	0.5	0.3	0.9
make drinks	0.1	0.1	0.4	3.1	0.3	---	0.7
transport	---	0.3	2.3	0.4	0.6	0.4	0.6
iron clothes	0.1	0.5	1.1	0.3	1.0	0.3	0.6
space heating	0.1	1.0	0.3	0.2	0.4	---	0.4
gardening	---	0.6	0.1	---	0.4	---	0.2
cooling	0.1	0.4	0.1	0.3	0.2	---	0.2
process food	0.6	---	---	0.2	0.2	---	0.2
artisan work	---	0.2	0.2	0.1	0.4	0.1	0.2
clerical work	---	---	0.2	---	0.2	---	0.1
make clothes	---	0.1	---	---	---	---	---

Most energy uses were in cooking, heating water, lighting, washing dishes, bathing and entertainment. A household energy project which concentrates on cooking and heating water alone would deal with more than 70 percent of all energy-using activities.

Table 25 shows the seasonal pattern of the most important of the activities listed in Table 24. In general, the expected

seasonal shifts are displayed in these data. Heating water, lighting and space heating go up sharply in the winter, while drinking and making drinks drop.

Table 25

End-Uses of Energy by Season

	Summer	Autumn	Winter
cooking	63.1	66.0	53.5
hot water	7.5	8.2	12.4
lighting	6.0	7.3	9.9
dish washing	6.4	4.3	6.5
bathing	4.0	4.8	4.0
entertainment	3.1	2.7	5.6
clothes wash	1.9	1.5	1.8
drinking	2.1	1.4	0.8
clean house	1.1	0.6	1.4
freezing	1.0	0.8	0.9
make drinks	1.0	0.9	0.1
transport	1.0	0.3	0.5
iron clothes	0.8	0.3	0.6
space heating	---	0.1	1.0

Table 26 lists the percentage of users of each major energy-consuming device for each purpose. Those uses of energy and water listed in Tables 24 and 25, not requiring a device, are omitted in the following discussion. For example, many cases of bathing or washing dishes or clothes did not require the use of an energy device, as these operations were done by hand using available cold water. Each of the categories is named, but the overall data base is somewhat different.

Clearly, for a very large number of households in the sample, the open fire serves many purposes--cooking, heating water and washing. The stove is more often used for cooking than the open fire, but heating water is more often done on the fire. Lighting is most commonly done with the hurricane lamp; electric light bulbs are the next most used device. The radio is by far the most common form of entertainment.

Table 27 lists the percentage of the total number of energy uses contributed by each of the main energy-using devices during the 24-hour periods of study in each of the six communities. The less commonly used devices are omitted from the table. Overall, fireplaces dominate, with gas stoves following second in the percent of total uses of energy. After cooling and heating devices, the devices used for lighting are next, with the candle being the most widely used.

Table 26

Principal Uses by Energy Device

	Cooking	Hot Water	Lighting	Wash Dishes	Bathing	Entertain	Wash Clothes	Making Drinks
open fire	38.8	39.5	1.2	64.8	72.0	0.2	39.5	49.7
stove	60.3	44.8	0.3	29.9	25.3	---	15.8	43.9
kettle	0.3	10.6	---	---	0.5	---	---	1.3
space heater	---	0.7	0.1	---	0.1	---	---	---
water heater	---	3.9	---	---	0.5	---	---	---
generator	0.1	---	1.5	---	0.5	0.1	---	---
candle	---	---	30.8	---	---	0.2	---	---
tin lamp	---	---	0.9	---	---	---	---	---
hurricane lamp	---	---	25.9	---	---	0.1	---	---
pressure lamp	---	---	0.9	---	---	---	---	---
Aladdin lamp	---	0.1	14.9	---	---	0.3	2.6	---
light bulb	---	---	21.2	---	---	0.6	---	---
radio	---	---	0.3	---	0.5	68.6	---	---
tape recorder	---	---	---	---	---	12.3	---	---
television	---	---	---	---	---	12.2	---	---
high-fi set	---	---	---	---	---	4.0	---	---
slide projector	---	---	---	---	---	0.3	---	---

Table 27

Households Using Energy Devices

	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	Mean
yard open fire	14.0	22.3	28.2	24.3	4.1	45.3	19.4
house open fire	0.9	8.3	0.9	9.3	8.6	1.6	5.1
yard fireplace	0.4	2.0	1.0	9.6	24.3	0.4	6.4
house fireplace	---	0.5	0.1	1.4	10.7	---	2.1
wood stove	5.5	15.7	7.9	16.8	2.0	28.3	11.4
paraffin stove	12.1	1.8	12.2	2.5	0.4	0.2	5.3
coal stove	---	---	4.2	---	---	---	0.6
gas stove	45.5	14.8	25.5	18.3	17.3	12.0	23.7
elec. stove	9.2	13.3	6.0	0.9	---	3.6	5.8
kettle	1.7	---	0.5	---	5.4	---	1.3
refrigerator	0.5	1.4	2.7	1.6	0.4	0.4	1.2
space heater	0.1	0.3	0.8	0.2	0.1	---	0.2
water heater	0.2	0.1	0.5	0.2	1.2	0.8	0.5
iron	0.1	0.6	1.4	0.3	1.0	0.2	0.6
candle	1.0	3.4	3.1	2.7	4.8	1.4	2.7
hurricane lamp	0.9	1.5	0.9	3.3	4.5	3.0	2.2
Aladdin lamp	---	1.0	0.1	2.0	4.2	0.5	1.3
light bulb	2.1	3.4	2.7	1.1	0.9	1.3	1.9
radio	1.1	4.3	5.4	2.7	4.7	0.1	3.1
television	0.8	0.5	0.8	0.2	0.1	---	0.5

Certain activities are probably too little represented, perhaps due to faulty questioning by enumerators. In particular, it is surprising that open fires are mentioned so much less in Molepolole than in the other centers. It may be that what one enumerator defined as an open fire another defined as an actual fireplace.

Table 28 reports the seasonal variation in use of the most commonly used devices, giving the percentage of all uses of energy which are attributed to each of the devices in each of the three seasons.

Table 28

Households Using Energy Devices by Season

	Summer	Autumn	Winter
yard open fire	16.8	18.9	13.8
house open fire	2.9	4.4	5.6
yard fireplace	6.1	5.1	5.1
house fireplace	1.0	2.1	2.5
wood stove	10.1	11.1	7.9
paraffin stove	6.1	3.8	3.4
coal stove	0.6	0.6	0.3
gas stove	20.2	20.8	19.2
electric stove	5.0	4.8	4.9
kettle	1.4	1.3	0.8
refrigerator/freezer	1.0	0.9	1.2
air conditioner/fan	0.2	---	0.2
space heater	---	---	0.5
water heater	0.2	0.1	0.7
generator	0.1	---	0.4
candle	2.0	2.2	2.7
hurricane lamp	1.6	1.9	2.5
Aladdin lamp	0.8	1.5	1.1
light bulb	1.1	1.3	2.5
radio	2.5	1.5	3.6
tape recorder/player	0.4	0.6	0.4
television/video player	0.2	0.4	0.8
phonograph/high-fi set	0.1	0.1	0.4
all vehicles	0.8	0.3	0.4

The expected seasonal variations in energy use appear in these data. There is less use of outdoor cooking facilities and more use of indoor stoves and fireplaces in the winter than in the summer. There is a strong trend toward more use of lighting devices in the winter, as well as more use of those types of entertainment which require the user to be indoors, e.g., television and high-fi equipment. Space heating and water heating are more common in the winter. The expected trend in use of expensive cooling devices,

including refrigerators, freezers, air conditioners and fans, does not appear, perhaps because their users are less concerned about saving money than the low-income households who must conserve their resources. Stoves are relatively less used in the winter, probably because of the relative increase in the use of lighting, heating and entertainment devices.

Enumerators asked wood-burning households exactly where they do their cooking. Table 29 lists the percent of the total number of cooking places reported in each strata of the times the family cooks in the main house, a separate kitchen, a shed in the yard, an open enclosure and out in the open. Some families cook in more than one place, depending on circumstances, and so the percents do not represent households, but rather places where people may cook.

Table 29

Cooking Places

	Very Low	Low	Middle	High	Very High	Mean
main house	19.8	24.9	40.4	60.8	64.0	35.2
separate kitchen	20.7	23.3	24.1	25.7	16.0	23.1
shed in yard	12.9	11.4	6.6	2.7	8.0	8.8
open enclosure	36.2	28.0	22.8	6.8	12.0	24.5
open yard	10.3	12.4	6.1	4.1	----	8.3

High- and very high-income households use the main house much more often than the other groups. The lower-income households cook much more often in the yard, whether in a shed or open enclosure, or simply on an open, unenclosed fire. Other data show that Gaborone respondents in general tend to cook more indoors than do respondents in other communities, most likely because there is less open space around houses and greater urban tendency toward privacy in the household than in more rural centers.

There is a slight tendency for people to cook indoors more often in the winter than in other seasons. There is a strong tendency for the cooking center to be determined by weather conditions. The main house and separate kitchen are more often used in rainy, cold and windy weather, if there is a choice to be made. The open shed in the yard or open yard itself is more likely to be used in dry and quiet weather than in windy or rainy weather.

The main foods prepared are the customary staple foods. Sorghum porridge accounts for 19.3 percent of all foods cooked, while maize meal porridge accounts for another 12.4 percent. Altogether, 16.3 percent of the foods cooked are meats, breads - 8.3 percent, vegetables - 6.1 percent, rice - 3.7 percent; whole-grain boiled maize kernels (called samp) - 2 percent, eggs - 1.8 percent, soup - 1.4 percent and beans 1.2 percent.

An additional 22.4 percent of all cooking occasions are used to prepare beverages, including tea, coffee, traditional sorghum beer (bojalwa) and a light alcoholic beverage made from wild fruits (khadi).

The percent of meat items is very high, reflecting both that Botswana is a cattle-producing country and that the survey was carried out in a drought year, when cattle-owners are slaughtering and selling animals at a greater rate than normally to prevent the animals from dying of starvation. As a result, beef has been very inexpensive and many people are buying and eating it. People in the towns eat slightly more imported products and slightly less traditional staple foods. This is doubtless due to the presence of expatriates and Batswana who have had international experience and have more money to spend on foreign foods.

Table 30 gives the mean time in minutes spent preparing and eating food, as a function of season and community. The figures represent the mean time for each individual food preparation task, not for the task of preparing the food for a single meal or the entire day.

Table 30

Time for Preparing and Eating Major Foods in Minutes

	Gaborone	Selebi-Phikwe	Lobatse	Serowe	Mole-polole	Palapye	Mean
Summer	36.3	122.1	94.2	79.2	102.6	51.4	84.3
Autumn	39.6	104.4	79.8	98.8	66.3	43.5	74.5
Winter	92.2	169.8	94.2	99.9	76.3	51.4	99.2
Total	60.3	121.5	103.0	93.6	83.4	49.2	86.5

Meal time and eating occupy a large proportion of the day for most families. Since Table 30 gives the mean time of preparation and eating for each individual food item, it is necessary to sum up all the individual items to arrive at the total day's time. Clearly, some of these operations overlap, so that the total time spent is not a simple product of the number of foods prepared, multiplied by the mean time of preparation and eating. On the other hand, with three meals per day as the Tswana norm, one can expect that the persons who prepare the meals--primarily children (21.6 percent), hired workers (21.2 percent) and wives (18.7 percent)--spend up to five or six hours a day at the task.

4.4.3 Knowledge of Stoves

Given that cooking is the largest household energy-use activity

among all survey strata and cooking represents a major expenditure of time, it is appropriate to focus briefly on the range of cooking technologies that are used in Botswana, as represented by the sample. Table 31 presents the stated familiarity with and preferences for particular types of cooking stoves among the survey respondents. The responses were surprising in a number of ways. First, the majority of respondents referred to wood and coal stoves as being one and the same technology, indicating awareness of only multifuel models, which have no fuel-efficiency specialization. Second, the gas stove received the best overall preference rating, regardless of the fact that the majority of households actually use wood as their principal cooking fuel.

It should be noted that preference was expressed by each respondent on a scale of decreasing preference, ranging from one to five. These mean preference rankings by stove type and strata are given in parentheses within strata columns.

Table 31

Familiarity with and Preference for Stove Type

	Very Low	Low	Middle	High	Very High	Mean % Familiar	Mean Pref. Rank
wood-coal	30.0 (1.9)	27.0 (2.2)	27.4 (2.0)	25.9 (2.3)	22.0 (2.2)	27.0	(2.1)
primus	11.3 (2.5)	9.3 (2.2)	7.9 (3.0)	5.7 (3.5)	4.4 (3.5)	7.9	(2.8)
paraffin	24.0 (3.2)	27.5 (2.3)	18.9 (3.1)	14.5 (3.5)	11.0 (3.0)	20.2	(2.9)
gas	26.7 (2.1)	25.8 (1.8)	26.5 (1.6)	29.4 (1.5)	29.7 (1.5)	27.1	(1.6)
electric	8.0 (3.2)	10.1 (2.5)	17.7 (2.1)	23.0 (2.1)	29.7 (1.8)	16.7	(2.2)
mud	--- (-)	0.3 (5.0)	0.8 (3.7)	0.7 (5.0)	1.1 (4.0)	0.6	(4.2)
mbaula	--- (-)	--- (-)	0.3 (4.5)	0.7 (4.0)	0.1 (-)	0.3	(4.3)

Respondents separated their reference to a simple primus stove from the more general reference to a paraffin stove, which could include both the primus and the bigger wick stove with possibly two or three burners. The mbaula is a homemade device in which an old bucket has holes punched in it for air circulation so that the fuel (wood, charcoal, dung or coal) can be burned for cooking or heating. The mud stove is an experimental stove which can be made at home. It was introduced by BRET and others in a few locations in Botswana. The same percentage of households mentioned gas stoves and wood-coal stoves, with roughly the same distribution across all income groups. Paraffin and primus stoves are mentioned mostly by the lower-income households, while electric stoves are mentioned more often by the upper-income families. The mud stove and mbaula are scarcely mentioned at all.

Very low-income households slightly prefer wood-coal stoves to the gas stove, while other stove types appeal selectively, apparently correlated to affordability of the fuel associated with the particular technology.

Table 32 lists the advantages possessed by each of the main stove types. The minor types, mud stove and mbaula, have been omitted as there were few comments made about them.

Table 32

Advantages of Stove Types

	Cooks Fast	Saves Money	Easy to Use	Multi-Purpose	Warms House	Clean	Lasts Long	Safe
wood-coal	8.5	45.6	9.6	20.5	25.1	0.3	12.9	7.3
primus	38.5	49.0	15.6	4.1	1.0	1.0	2.1	3.1
paraffin	21.1	66.1	23.9	9.2	---	1.2	1.2	2.8
gas	66.8	19.7	22.1	5.4	1.3	11.4	8.0	0.5
electric	57.9	7.3	25.5	12.3	0.5	23.1	1.8	8.1

There is a tradeoff between saving money, as in the case of wood, coal and paraffin stoves, and quick cooking, as with gas and electricity. The one closest to a compromise is the gas stove, which is believed to both allow fast cooking and be economical. Wood and coal stoves have the additional advantage of warming the house, while the electric stove has the advantage of being clean.

Table 33 lists the corresponding disadvantages of the various stove types, once again omitting the mud stove and mbaula.

Table 33

Disadvantages of Stove Types

	Expen-sive	Danger-ous	Smokey/ Dirty	Slow to Cook	Cannot Regulate	Wastes Heat	Hard to Use
wood-coal	36.0	4.5	45.9	11.4	0.6	15.6	5.1
primus	28.6	44.8	23.9	6.7	3.9	3.8	---
paraffin	33.8	39.0	25.4	18.3	1.1	4.5	1.1
gas	33.9	61.7	3.6	1.7	16.9	0.6	0.6
electric	76.7	18.6	1.9	3.3	16.3	1.4	---

Here, too, there is a similar tradeoff between devices. Wood and coal are safe and relatively inexpensive, but smokey and dirty. Electricity is relatively safe, clean and fast, but expensive. Paraffin is relatively cheap, but somewhat dangerous, smokey and slow. Gas, perhaps, has the best combination of disadvantages, although it is high on the danger scale and has a problem with regulation in that it may run out without warning.

Respondents were asked to name the principal advantages of their individually most preferred stove type. Interestingly, there

was a very high degree of similarity in responses across income strata. The fact that a particular stove cooks fast or saves money received 37.5 percent and 36.7 percent of the response, respectively. Other advantages listed were easy to use (19.6 percent); multi-purpose (9.2 percent), warms house (7.8 percent), clean (7.4 percent), last long (6.8 percent) and safe (4.4 percent). Seemingly, all respondents recognized the objective facts about the advantages of different stove types, although their pattern of use is quite different. Again, the differences are apparently due to the issues of technology cost in relation to disposable income.

Respondents were also asked to name the principal disadvantages of their individually most preferred stove type. Again, there was a very high degree of agreement across income strata. The responses were, in descending order of disadvantage, expensive (41.1 percent), dangerous (33 percent), smokey/dirty (20.9 percent), slow to cook (10.6 percent), cannot regulate (8.3 percent), wastes heat (5.6 percent) and hard to use (1.8 percent).

4.4.4 Renewable Energy Technology Devices

Respondents were questioned about the types of renewable energy-powered devices with which they were generally familiar. From the responses, it is apparent that the majority of respondents do not normally consider particular technologies as being powered by either renewable or conventional fuels/energy sources and, thus, do not readily understand the significance of these energy-saving devices. Solar hot water heaters were the most widely recognized RET, while bicycles were the most generally not recognized RET among those listed. Interestingly, respondents of Gaborone were not those most familiar with a wider range of RETs in use in Botswana, as one would normally expect of residents of a capital city.

When asked about the principal advantages of RETs, respondents who specifically named such devices suggested that fuel savings, renewable energy sources and the relatively inexpensive nature of maintenance were the most important advantages. Among principal disadvantages specifically mentioned are solar-powered devices require sunshine to operate, the technologies are expensive to purchase, they cannot be used on their own, wind technologies require wind to operate, food is cooked more slowly, the devices don't last long and can be dangerous. The range of responses seems to indicate a basic low level of understanding of RETs. After a brief instructional discussion between the enumerators and respondents, which involved a wider range of technologies than those specifically named, the wonder box was consistently most interesting to all strata, the photovoltaic cell was of specific interest to the higher-income households, while the metal stove was of greater interest to wood-burning households. The main interest in most of the RETs was their relatively inexpensive purchase price and the fact that they save fuel.

Given the potential for coal development in Botswana and the relative lack of interest among survey respondents to the use of coal as a primary cooking and heating fuel, the questionnaire included several questions which addressed coal specifically. Respondents were asked if they would use coal for cooking and heating if it were available at half the cost of their present fuel(s) used for these purposes. Wood users responded strongly positive that they would be willing to use coal under these conditions, with over 80 percent so stating. Paraffin users responded with over 75 percent saying they would switch to coal; over 73 percent of the gas users were willing to shift to coal under these cost conditions and over 66 percent of the electric users were willing to convert. Those in the latter three fuel-using categories were less willing to shift from their present fuel to coal because of its relative dirtiness.

Given the relative importance of cooking among all other energy-using activities of the Batswana households, several questions were asked of respondents which addressed cooking technologies. Respondents were asked if they would consider shifting from their present cooking technology to the substitution of or the addition of a new metal stove, wonder box or newly designed mud stove if that technology demonstrated a 10, 20, 30, 40 or 50 percent wood savings. Not surprisingly, those persons now cooking with wood were those most interested in using a new metal stove, with over 60 percent of those currently wood-using respondents willing to shift to a new metal stove, even if it represented only a 10 percent wood savings. However, those respondents currently cooking over open fireplaces would not really be interested in shifting to a newly designed mud stove unless it demonstrated a wood saving of at least 40 percent. Of those respondents currently using fuels other than wood for cooking, a technology shift might occur if the new metal stove demonstrated at least a 50 percent wood savings, and even then, less than 50 percent of the electricity users are interested. Somewhat surprisingly, the wonder box is more attractive to higher-income families than to lower-income families. Further, women respondents tend to be less interested in the wonder box than men. All respondents, regardless of income strata, indicated a preference to make rather than buy a wonder box. Overall, the responses to this set of questions regarding energy-saving cooking technologies strongly indicate the high risk-avoidance behavior of the lowest-income households among those surveyed. Generally, they displayed resistance to change which seemed to be associated with the need to invest money in technologies which represent change.

Finally, respondents were asked if they would be willing to purchase photovoltaic (PV)-powered, residential electricity systems for domestic appliance operation and solar-powered hot water heaters for home use. It appears from the responses that there are two types of constraints limiting the interest of the middle- and lower-income households in acquisition of these two types of systems. First, the initial purchase price of the PV

system(s) is prohibitive among the majority of middle- and lower-income families. However, among higher-income households, the systems seem to display relative price elasticity in that a similar percentage of respondents would be willing to purchase such a system at one suggested price and then at double that initially suggested price. Second, the roof solar hot water heater technology is limited to households which have piped water distribution systems inside the house.

5.0 CONCLUSIONS AND IMPLICATIONS

The results of the Urban Energy Survey have reinforced several important concepts which are held to be universally applicable in the economics and sociology disciplines, when considering the process of national economic development:

- In the process of national economic development, as family household income increases, there is an accompanying shift in available disposable income and consumer preference toward higher-value goods and services; and

- household investment decisions regarding the adoption of new, improved technology are strongly modified by the relationship of available disposable income and individual perceptions of the presence of risk and uncertainty.

The importance of understanding the constraints and opportunities presented by the validation of these two socioeconomic concepts for prioritizing the RET-applied research and dissemination activities of the BRET program should be kept firmly in mind.

Analysis of the survey data across five income strata within the sample has demonstrated that as income increases, Batswana households consume more aggregate energy per capita and on a daily basis. The increased energy consumption has two characteristics of importance to the technology development activities of BRET. First, the increased energy consumption occurs in a shift to higher-value (more expensive and nonrenewable) energy sources, as well as an increase in the gross consumption of a range of energy sources. Second, the increase in available disposable income manifests itself in the consumption of a wider range of energy-using household appliances and systems. The data have shown a fairly clear progression of household energy use ranging from a reliance on one principal fuel to provide energy for one or two primary energy-using activities within the lowest-income households to a dependence on a majority of the available energy sources to provide energy to a number of household activities within the higher-income households. The implications of these facts for BRET are in the area of opportunities for the development of a wide range of energy-saving technologies which can conserve fuels by increasing the efficiency of their use in lower-income households, and which can substitute renewable energy sources for conventional fossil fuel consumption while increasing the efficiency of energy use in the higher-income households.

Examination of attitudinal data collection during the survey, combined with the BRET experiences with technology transfer in Ditshegwane and Shoshong before the survey, has strongly reinforced the concept of risk avoidance in relation to new technology

adoption among lower-income households. This situation is especially true for the lowest-income households responding to the survey questions. Families whose available disposable income is marginal and insecure have demonstrated almost complete aversion to changes suggested in not only the technologies which use energy for basic household operations (such as cooking and heating water), but also to changes in the systems of fuel acquisition. The implications of this information for BRET are in the area of constraints to the development of new technologies which use available fuels more efficiently for families within the lowest-income households. Development of these new technologies should proceed on a modest scale in the BRET program; however, the major emphasis will have to be placed on the development of appropriate dissemination strategies which rely less on a formal process of transfer and more on the informal diffusion process which occurs naturally within society. This latter process will require a clear understanding of the structure(s) of this informal process in village society and the subsequent development of information dissemination programs which reach the critical links in this structure. Of course, simultaneously, BRET will have to make sure that a stream of new technologies is available for adoption as the agents of change begin to provide catalysts in this informal diffusion process.

There is also a measure of reluctance to accept change among the highest-income households responding to the survey. However, this behavior and these attitudes cannot reasonably be explained by the concept of risk avoidance, as is the case with the lowest-income families. The social dynamics which could be at the seat of aversion to change at the highest-income levels are beyond the scope of this analysis and, therefore, will not be taken up in this report. However, it will be important to BRET to understand the nature and scope of these attitudes in targeting the energy sources and technologies powered by these sources, which they hope to modify and perhaps replace.

Recognition of these constraints at this time is a recognition of opportunities for BRET technology development. The attitudinal data have clearly demonstrated the interest in and ability to change among the larger segment of Batswana society and across the widest range of fuels and technologies. Among those households surveyed in this study, only 20.5 percent were classified as in the lowest- and highest-income groups, leaving a target group of approximately 80 percent of the population. This is not to say that households which fall into the two income extremes should be ignored by BRET program activities, but is to say that interventions planned for these two income groups should be selective and that the largest area of opportunity across the widest spectrum of energy use will be with households not belonging to the income fringe in Batswana society.

Within the opportunities set, analysis of the survey data has provided information which should be of use to BRET in its

efforts to prioritize subsequent applied research, technology development and dissemination activities in the realm of renewable energy. Probably the most important finding is that cooking is the largest energy-consuming activity of households, across income strata in Botswana, following by water heating. Seasonal variation of energy consumption is not significant. Technology development should clearly focus on these two activities, in that they account for over 70 percent of household energy use.

Among the sample households, those using wood as their principal cooking fuel range from a surprising 24 percent in Gaborone to 86 percent in Palapye, with a mean number of households across the six communities of 56 percent. Gas-using households (as the principal cooking fuel) rank second in terms of number, ranging from 50 percent in Gaborone to 13 percent in Palapye, with a mean of 29 percent. These figures strongly indicate that among the five principal fuels used in Botswana, i.e., wood, paraffin, coal, gas and electricity, wood and gas deserve special attention in BRET planning.

In terms of attitudinal data, the most important set of responses seems to indicate that for the majority of households, energy in itself is not viewed as a problem. Rather, the cost of energy supplies is a very important problem. This response indicates a lack of education regarding the relationship between the total available supply of energy and the cost of that energy--that is, the economics of supply and demand. The vast majority of respondents noted that the cost of fuels (regardless of type) had increased during the recent past. The only reason for such cost escalation, in the absence of artificially imposed government price supports, is relative scarcity. While it is possible to argue that gross aggregate supplies of domestic energy and/or stability of imported supplies in foreign markets (e.g., the Republic of South Africa) may be such that aggregate supply apparently meets or exceeds aggregate demand for energy, this is not indicative of how fuel prices are set in the domestic marketplace or the oost to consumers. The fact that the majority of people do not recognize that fuels of all varieties are scarce in Botswana does not auger well for successfully or perhaps easily instilling a conservation mentality in the population. This indicates that for BRET, as well as the government institutions responsible for energy supply, there is a requirement to build into technology development and dissemination programs a series of information programs designed to raise the issue of energy scarcity and the need for conservation of energy with the population. There is a clear relationship between the adoption of energy-saving technology and long-term cost saving. This message should be passed on to the population before a widely successful RET development and dissemination program can be achieved.

Related to this public perception of energy supply is an overwhelming response to a series of questions regarding responsibility for resolution of energy supply programs. While the

majority of those responding indicated that regulation of unbridled cutting of trees for fuel should occur, the seat of responsibility was clearly seen to be with larger authority organizations, such as tribal councils or central government ministries. Most respondents did not recognize the connection between individual conservation efforts and resolution of energy supply problems at the national level, whereas they did have the opinion that top-down problem resolution would be the most effective action. While the issue of national fuelwood management is not one which BRET will be asked to deal with, the importance of these commonly held attitudes toward the role of individual action in relation to energy conservation should be addressed by BRET in connection with with its dissemination efforts.

Finally, with respect to public awareness of RETs in general, the survey results indicate a general level of awareness of specific technologies, such as the solar water heater. However, there was a general lack of appreciation for the significance of the RET. The majority of respondents indicated that while they were aware of the physical technology, they did not think of it in terms of the energy source being used to power it, nor the implications of its use in terms of longer-term financial savings to the individual and positive contribution to national energy supply objectives. For BRET program development, it appears that this level of knowledge will be important to the continuing acceptance of RETs in Botswana.

APPENDICES

APPENDIX A

Study Terms of Reference

of Domestic Energy Use in Towns/Major Villages

A. INTRODUCTION

1. This study is being conducted by the Botswana Renewable Energy Technology (BRET) project on behalf of the Ministry of Mineral Resources and Water Affairs. The study will assist BRET in the development and dissemination of renewable energy technologies (RETs) and provide input on the urban domestic sector for the national energy masterplan.

B. BACKGROUND

2. BRET, a pilot of MMRWA, is to research, develop and field test RETs that will conserve fuelwood and reduce dependence on imported petroleum-based fuels. In order to select technologies for use in rural areas, BRET conducted Village Energy Studies in two rural villages.

The study of major villages and towns will complement this effort and assist BRET in determining whether technologies developed for rural domestic use may have application in urban areas.

3. BRET will work closely with the Rural Energy Study by ODA consultants to complement their work of studying energy utilization and requirements in the rural sector of Botswana and provide the necessary input to the National Energy Masterplan.

C. THE SCOPE OF THE STUDY

4. The study will be carried out in six locations: Gaborone, Molepolole, Lobatse, Serowe, Palapye and Selebi-Phikwe. Approximately 600 households will be studied intensively during summer, fall and winter, 1984. Approximately 96 households will be studied in each site for three days each in summer, fall and winter. The stratified sample will be selected randomly to include at least 15 upper-income, 36 middle-income and 45 lower-income households at each field site.

5. The evaluation criteria for the study include:

   a. Kcal equivalents per household per year of wood, charcoal, dung, coal, bottled gas, paraffin, candles, solar, wind, electricity.

   b. Fuel source by quantity, by task.

c. Demographic characteristics of household: age, sex, absentees, schooling, occupation, etc.

d. Attitudes of householders toward energy requirements, fuels (preferred/status, source, current and ideal practices, fuel availability, fuels).

e. Household infrastructure: type of housing, domestic facilities/appliances/tools, transport ownership.

f. Overall household internal economy: income sources, expenditure, economic activities, etc.

D. WORKPLAN

The primary consultant, Dr. John Gay, will work for approximately 50 person-days to design the survey, train the enumerators, develop computer programs for data analysis, complete the analysis and prepare the report. He will work from January 10 to the end of February and again during April and September, 1984.

Key dates are as follows:

January, 1984 - survey design
enumerator training
establishing contact with local authorities

All field work will be supervised full-time by a locally hired consultant. Eighteen enumerators will carry out field work as follows:

Jan. 30-Feb. 1	Selection of first 16 households
Feb. 2-Feb. 15	Interviewing first 16 households
Feb. 16-18	Selection of second 16 households
Feb. 20-March 3	Interviewing second 16 households
March 5-21	Coding first set of interviews
March 22-31	Gathering background data
April 4-18	Starting second round of interviews
April 19-25	Easter break
April 26-May 5	Completing second round of interviews
May 7-23	Coding second set of interviews
May 24-June 2	Gathering background data
June 4-30	Third round of interviews
July 2-21	Coding third set of interviews
July 23-Sept. 1	Entering coded data on computer
Sept. 3-22	Data Analysis and report writing

APPENDIX B

Order of Interview Topics

At each interview the energy/water supply and eneergy/water/food use sheets should be filled in. These parts of the survey will thus be ocne a total of nine times.

In addition, at each interview a particular set of questions should be asked, according to th following list.

Interview	Topics
1	Knowledge of energy devices, inventory of energy using devices.
2	Family members
3	Structures
4	Toilets; water supply; farm tools, farm workers, fields/gardens, crop production.
5	Trees; wood-burning household questions.
6	Types of fuel types of firewood.
7	Questions on fuel use.
8	Questions on specific fuels and devices.
9	Problem in life arrangement with energy-related statements; conclusion.

After the household inttrviews are completed for each season, fuel sellers and energy device sellers should be interviewed, and observations should be made in fuelwood areas.

What types of stotves do you know about, when are their prices, what are the advantages and disadvantages of each, what are your oreferences and why?

TOWN_____DATE_____ENUMERATOR_____FAMILY NAME_____NUMBER__

KNOWLEDGE OF ENERGY DEVICES

STOVE TYPE	PRICE	ADVANTAGES	DISADVANTAGES	PREFERENCE	REASON
1					
2					
3					
4					
5					

What other types of energy-saving or renewable-energy devices do you know about? Describe them and tell the advantages and disadvantages of each.

DEVICE	DESCRIPTION	ADVANTAGES	DISADVANTAGES
1			
2			
3			
4			
5			
6			

TIME_____ DATE_____ ENUMERATOR_____ FAMILY NAME_____ NO._____

INVENTORY OF ENERGY USING DEVICES

DEVICE	ENERGY SOURCE	NUMBER	SIZE	OWNERSHIP
1				
2				
3				
4				
5				

24				
25				
26				
27				
28				
29				
30				

DEVICE	ENERGY SOURCE	SIZE	OWNERSHIP
OUTDOOR OPE FORE	HUMAN	SMALL	
INDOOR FIREPLACE	ANIMAL	MEDIUM	
OUTDOOR FIREPLACE	WOOD	LARGE	
INDOOR FIREPLACE	CHARCOAL		
STOVE	OILS		
KETTLE	FARM RESIDUES		
TOASTER	TWIGS/LEAVES		
ROASTER	CARDBOARD		
HOT PLATE	GARBAGE		
MIXER	COAL		
FOOD DRYER	BOTTLE		
REFRIGERATOR	PETROL		
FREEZER	DIESEL		
AIR CONDITIONER	CANDLES		
FAN	BATTERIES		
SPACE HEATER	ELECTRICITY		
WATER HEATER	SOLAR		
WASHING MACHINE	WIND		
CLOTHES DRYER			
PAPER DRYER			
VACUUM CLEANER			
SEWING MACHINE			
KNITTING MACHINE			
DRILL			
SAW			

LAWNMOVER
MILL
GENERATOR
PUMP
WINDMILL
CALCULATOR
CANDLE
HURRICANE LAMP
TORCH
RADIO
TAPE RECORDER
TELEPHONE
BICYCLE
MOTORCYCLE
TRACTOR
PICKUP TRUCK
SALOON CAR
STANTION WAGON
LORRY

CODES FOR ENERGY/WATER SUPPLY

TYPE	SOURCE	COLLECT METHOD	STORE METHOD
HUMAN	SPRING	DELIVERED BY SELLER	BUCKET
ANIMAL	WELL	CARRIED BY FAMILY	TANK
WOOD	BOREHOLES	CARRIED BY WORKER	BOX
CHARCOAL	OUTSIDE TAP	BICYCLE	SHED
DUNG	TAP IN YARD	CAR	BAG
FARM RESIDUES	TAP IN HOUSE	LORRY	DRUM
TWIGS/LEAVES	VENDOR/HAWKER	PICKUP TRUCK	TIN
CARDBOARD	GENERAL DEALER	DONKEY CART	BATTERY
PARAFFIN	LARGE SHOP	OX CART	DAM
COAL	SUPERMARKET		BOTTLE
BOTTLED GAS	HOME/GARDEN		CYLINDER
PETROL	LANDS		HEAD
DIESEL	CATTLE POST		
CANDLES	OPEN COUNTRY		
BATTERIES	GOVERNMENT		
ELECTRICITY			
SOLAR			
WIND			
WATER			

CODES FOR ENERGY/WATER/FOOD USE ENERGY

USE	USER	DEVICE	ENERGY SOURCE
COOKING	HEAD	OUTDOOR OPEN FIRE	HUMAN

MAKING DRINKS	SPOUSE	INDOOR OPEN FIRE	ANIMAL
DRYING FOOD	CHILD	OUTDOOR FIREPLACE	WOOD
MILLING GRAIN	PARENT	STOVE	CHARCOAL
SPACE HEATING	COUSIN	KETTLE	DUNG
COOLING	UNCLE/AUNT	TOASTER	FARM RESIDUES
FREEZING	GRANDPARENT	ROASTER	TWIGS/LEAVES
LIGHTING	GRANDCHILD	HOT PLATE	CARDBOARD
TRANSPORT	OTHER RELATIVE	MIXER	PARAFFIN
			COAL
WASHING CLOTHES	HIRED WORKER	FOOD DRYER	BOTTLED GAS
WASHING DISHES	FARMER PERSON	REFRIGERATOR	PETROL
HOUSE CLEANING	RESTAURANT	FREEZER	DIESEL
BATHING	COMMERCIAL	AIR CONDITIONER	CANDLES
SWIMMING POOL	WHOLE FAMILY	FAN	BATTERIES
PUMPING		SPACE HEATER	ELECTRICITY
GARDENING		WATER HEATER	SOLAR
FARMING		WASHING MACHINE	WIND
CONSTRUCTION		CLOTHES DRYER	
MANUFACTURE		HAIR DRYER	
REPAIR WORK		VACUUM CLEANER	
MAKING CLOTHES		SEWING MACHINE	
PRESSING CLOTHES		KNITTING MACHINE	
CLERICAL WORK		IRON	
ENTERTAINMENT		LATHE	
DRINKING		DRILL	
		SAW	
		LAWNMOWER	
		[illegible]	
		GENERATOR	
		[illegible]	
		WINDMILL	
		[illegible]	
		CALCULATOR	
		[illegible]	
		CANDLE	
		[illegible]	
		[illegible]	
		PRESSURE LAMP	
		[illegible]	
		[illegible]	
		FLUORESCENT LAMP	
		TORCH	
		RADIO	
		TAPE RECORDER	

TAPE PLAYER
TELEVISION

VIDEO PLAYER
VIDEO PLAYER
PHONOGRAPH

TELEPHONE
BICYCLE
MOTORCYCLE
TRACTOR
PICKUP TRUCK

SALON CAR
STATION WAGON
LORRY

TOWN_____ ENUERATOR_____ FAMILY NAME_____ NUMBER____

ENERGY/WATER SUPPLY

DATE	TIME	TYPE	AMOUNT PRESENT	ADDED IN 24 HOURS	SOURCE	DISTANCE	TIME	MONEY SPENT	COLLECT METHOD	STORE METHOD

TOWN ________ ENUMERATOR ________ FAMILY NAME ________ NUMBER ____

ENERGY/WATER/FOOD USE

DATE	START TIME	TIME SPENT	USE	USER	ENERGY DEVICE	ENERGY SOURCE	ENERGY AMOUNT	WATER AMOUNT	FOOD TYPE	FOOD AMOUNT	NUMBER FED

TOWN_____ DATE_____ ENUMERATOR_____ _FAMILY NAME_____ NO.____

FAMILY MEMBERS

NAME	RELATION TO HEAD	SEX	AGE	HIGHEST SCHOOL	MARITAL STATUS	PRESENT	YEARS IN WORK	INCOME GROUP	ORGANIZATIONS

RELATION TO HEAD	SEX	PRESENT WORK		INCOME GROUP	ORGANIZATIONS
1 HEAD	1 MALE	0 NONE	10 MANAGER	0 NONE	0 NONE
2 SPOUSE	2 FEMALE	1 HOUSE WIFE	11 BEER SELLER	1 1-50	1 CHURCH
3 CHILD		2 FARMER	12 WATCHMAN	2 51-100	2 POL PARTY
4 PARENT		3 ARTISAN	13 DAY LABORER	3 101-200	3 BURIAL
5 SIBLING	MARITAL STATUS	4 CLERK	14 POLITICIAN	4 201-300	4 RED CROSS
5 VENDOR/ HAWKER	15 DOCTOR/ NURSE	5 301-400	5 YWCA		6 COUSIN
7 UNCLE/AUNT	1 SINGLE	6 TEACHER	16 STUDENT	5 401- 600	6 BCW
8 GRANDPARENT	2 MARRIED	7 MINE LABORER	17 SECRETARY	7 601-1000	7 BRIGADES
9 GRANDCHILD	3 SEPARATED	8 CIVIL SERVANT	18 LAWYER	8 1001+	8 SPORTS
10 OTHER RELATIVE	4 DIVORCED	9 DOMESTIC WORKER	19 POLICE MAN	9 MISSING	9 PTA

5 WIDOWED

10 VDC

11 TRADE UNION

12 4-B CLUB

STRUCTURES

BUILDING TYPE	ROOF THICK	ROOF MATER-IAL	WALL MATER-IAL	FLOOR MATER-IAL	CEILING TYPE	WINDOW NO.	WINDOW NO.	ROOM NO.	FRONT DIREC TION
1									
2									
3									
4									
5									
6									

(Draw outlines of all structures on back of sheet, with lengths of all sides in meters.)

BUILDING TYPE	ROOF TYPE	ROOF THICKNESS	WALL MATERIAL	FLOOR MATERIAL	CEILING MATERIAL	WINDOW TYPE
1 MAIN HOUSE	1 ROND-AVEL	1 THIN	1 MUD	1 MUD	1 HARD BOARD	1 HOLE
2 KITCHEN	2 SERETSE	2 MEDIUM	2 CEMENT	2 CEMENT	2 SOFT BOARD	2 FRAME ONLY
3 GARAGE GLASS	3 MATHE-	3 THICK	3 BRICK	3 DUNG	3 MAT	3 WOOD
4 SERVANT	4 ZINC		4 ZINC	4 TILE	4 CEMENT	4 METAL GLASS
5 SHED BOARD	5 TILE		5 CARD/ GLASS	5 WOOD	5 ASBESTOS	5 FIXED
6 TOILET	6 ASBESTOS		6 WOOD	6 LINO-LEUM		
7 POOL	7 SAIL		7 ASBESTOS	7 CARPET		
			8 SAIL	8 METAL		

FRONT DIRECTION: 1 NORTH. 2 NORTHWEST. 3 WEST. 4 SOUTHWEST. 5 SOUTH. 6 SOUTHEAST. 7 EAST. 8 NORTH EAST.

TOWN_____DATE_____ENUMERATOR_____FAMILY NAME_____NUMBER___

TOILETS		WATER SUPPLY			FARM TOOLS		FARM WORKERS	
	NUMBER		NUMBER	DISTANCE		NUMBER		NUMBER
SIMPLE PIT	_____	SPRING	_____	_____	PLOUGH	_____	FAMILY	_____
COMPLEX "	_____	WELL	_____	_____	PLANTER	_____	HIRED	_____

TOWN FLUSH _____ BOREHOLE _____ _____ CULTIVATOR___
SEPTIC " _____ COMMUNAL TAP _____ _____ HARROW _____ TOTAL _____
TAP IN YARD _____ _____ YOKE _____ WAGES _____
INSIDE TAP _____ _____ CART _____

FIELDS/GARDENS CROP PRODUCTION CROPS

DISTANCE	HECTARES	NORMAL CROPS	EXPECTED KG	BEST KG	USE	CROPS
						1 MAIZE 13 CARROTS
						2 S/GHUM 14 S/FLOWER
						3 BEANS 15 MELON
						4 MILLET 16 G/NUT
						5 W/MELON 17 POTATOES
						6 S/REED 18 S/
						7 TOMATOES 19 COWPEA
						8 SPINACH 20 ORANGE
						9 WHEAT 21 COTTON
						10 PUMPKIN
						11 ONIONS
						12 CABBAGE

USE
1 FAMILY FOOD 2 SALE 3 PROCESS FOR SALE 4 FEED ANIMALS 5 EXCHANGE

INVESTOCK USE
1 CATTLE 1 SELL ANIMAL
2 GOATS 2 SELL PRODUCT
3 DONKEY 3 FAMILY FOOD
4 MULE 4 TRANSPORT
5 SHEEP 5 CROP FARM
6 GOAT 6 HIRE OUT
7 PIG 7 EMERGENCY
8 CHICKEN 8 WEALTH

TREES	USE		NON PLANTED TREES USES	
1 EUCALYPTUS 16 MOROJA	1 HOME FIREWOOD	1 HOME	1 HEAD	
2 MOTANE 17 [illegible]	2 SELL FIREWOOD	2 GARDEN	2 SPOUSE	
3 MORULA 18 MOSALADSE	3 HOME FRUIT	3 LANDS	3 CHILD	

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4 PINE	19 MOTSETSE	4 SELL FRUIT	4 CATTLE POST	4 PARENT
5 MANGO	20 GRAPE	5 WINDBREAK		5 SIBLING
6 PEACH	21 BAOBAB	6 FENCE		6 COUSIN
7 ORANGE	22 MOTSWERE	7 FLOWERS		7 UNCLE/AUNT
8 GRAPEFRUIT	23 FIG	8 SHADE		8 GRANDPARENT
9 GUAVA	24 MOGORWA-GORWANA			9 GRANDCHILD
10 PAPAYA	25 HEDGE			10 OTHER RELATIVE
11 ACACIA				11 HIRED WORKER
12 JACARANDA				12 GOVERNMENT
13 BANANA				13 WHOLE FAMILY
14 MOGONONG				
15 MULBERRY				

TOWN_____DATE_____ENUMERATOR_____FAMILY NAME_____NO._____

QUESTIONS FOR WOOD-BURNING HOUSEHOLDS

GEEKING PURPOSE_____

PLACE	PURPOSE	SEASONS	GATHER HOW OFTEN	TIME
1				
2				
3				
4				
5				
6				

PLACE	PURPOSE	SEASONS	WEATHER CONDITIONS	TIME
1 MAIN HOUSE	1 COOKING	1 SPRING	1 RAINING	1 REGULARLY 1 MORNING
2 SECRATE	2 HEATING	2 SUMMER	2 DRY	2 MORE OFTEN 2 NOON
3 SHED	3 LIGHTING	3 AUTUMN	3 HOT	3 RARELY 3 EVENING
4 KRAL	4 TEA	4 WINTER	4 COLD	4 NIGHT
5 OPEN ENCLOSURE	5 BREWING	5 ANY	5 WINDY	5 ANY TIME
			6 RAINY	
			7 ANY	

COOKING UTENSILS

UTENSIL	SIZE DIAMETER	WILL BUY NEW	USE TRIPOD	TRIPOD SIZE
1				
2				
3				
4				
5				
6				
7				
8				

UTENSIL	TRIPOD	WILL BUY NEW
1 3-LEGGED POT	1 3 STONES	1 YES
2 PAN	2 METAL	2 NO

TOWN_____DATE_____ENUMERATOR_____ENERGY DEVICE SELLER_____

QUESTIONS FOR ENERGY DEVICE SELLERS

ENERGY DEVICE	ENERGY SOURCE	WHERE OBTAINED	TRANSPORT	COST PRICE	SALE PRICE	MONTHLY SALES	PREFERENCE	REASON
1								
2								
3								
4								
5								
6								
7								
8								

9							
10							

ENERGY DEVICE	ENERGY SOURCE	WHERE OBTAINED	TRANSPORT
(Use codes for energy/ water/food use)		1 HOME MADE	1 DELIVERED BY SELLER
		2 INFORMAL BUSINESS	2 CARRIED BY FAMILY
		3 FRIEND	3 CARRIED BY WORKER
		4 FAMILY	4 BICYCLE
		5 GENERAL DEALER	5 CAR
		6 SUPERMARKET	6 LORRY
		7 WHOLESALE	7 PICKUP
		8 GOVERNMENT	8 DONKEY CART
		9 FOREIGN IMPORT	9 OX CART
			10 RAILWAY

What problems do you have with getting or selling energy devices and how can you solve them

TROUBLE	SOLUTION
1	
2	
3	
4	
5	

How many troubles do you have, how regular are they, and what types of people are they?

TOWN _____ DATE _____ ENUMERATOR _____ FAMILY NAME _____ NUMBER _____

QUESTIONS ON FUEL USE

1. What are the biggest differences in fuel use between now and 2 years ago?

2. What are the differences in fuel cost (either money spent or time spent) between now and 2 years ago? Be as precise as possible.

3. What are the biggest changes in fuel use between now and when you were a child?

4. What is the most serious fuel problem you have ever experienced?

5. When did it happen and under what conditions?

6. What did you do to solve the problem and how successful were you?

7. When during the last two years was fuel unavailable and what fuel was it?

8. How many times did this happen and for how long altogether?

9. What did you do to solve the problem and how successful were you?

10. When did people start paying for firewood instead of getting it free, and why?

11. Who do you think should be responsible for controlling the use of communal firewood trees, and why?

12. How can this best be done so that everyone has enough firewood?

13. What do you do or what can people do to use less firewood?

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TOWN_____DATE_____ENUMERATOR_____FAMILY NAME_____NUMBER_____

QUESTIONS ON SPECIFIC FUELS AND DEVICES

1. If coal were easy to get, under what conditions would you use coal in preference to other fuels?

2. Would you use coal if you could buy an efficient coal stove for

P50	YES	NO
P125	YES	NO
P300	YES	NO
P500	YES	NO

3. If coal cost your present fuel would you use it for

	HALF		THE SAME		TWICE	
COOKING	YES	NO	YES	NO	YES	NO
HEATING	YES	NO	YES	NO	NO	NO

NAME PRESENT FUEL _____

4. Would you buy a wood-burning metal stove which cost P15 and would last for 3 years if it used sticks of wood instead of 10 now?

9		8		7		6		5	
YES	NO	YES	NO	YES	NO	YES	NO	YES	NO

5. Would you make an earthen stove which needed 2-3 days work and would last for 3 years if it used sticks of wood instead of 10 now?

9		8		7		6		5	
YES	NO	YES	NO	YES	NO	YES	NO	YES	NO

6. At what price would you be willing to buy a solar water heater to put

IN YOUR ROOF_____
IN YOUR YARD_____

that would heat enough water for your family's washing and bathing?

7. Have you heard of a box into which you put your food to finish cooking but which needs no fuel? YES NO If yes, what was your experience with it?

8. Would you buy such a box for P20 YES NO or make it using 4-5 hours work YES NO if it used sticks of wood instead of 10 now?

9		8		7		6		5	
YES	NO	YES	NO	YES	NO	YES	NO	YES	NO

9. Would you buy a photovoltaic system which would run a radio and 2 light bulbs for a total cost of P700? YES NO plus a refrigerator for P1400? YES NO

10. Which of all the possibilities listed above interest you the most and why?

11. If you use firewood, what size of wood do you usually use?

DONT USE___TWIGS___SMALL STICKS AND BRANCHES___BIG TRUNKS AND BRANCHES___

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TOWN _____ DATE _____ ENUMERATOR _____ FAMILY NAME _____ NUMBER ___

AGREEMENT WITH ENERGY-RELATED STATEMENTS

For each of the following statements tell whether you

1 disagree strongly
2 disagree mildly
3 are neutral
4 agree mildly
5 agree strongly

1 2 3 4 5	If I plant trees, someone else will cut them down.
1 2 3 4 5	Poor people will always remain poor.
1 2 3 4 5	If I save water, it helps everyone in my community
1 2 3 4 5	If I save fuel, it helps everyone in my community.
1 2 3 4 5	There should be strict laws to control cutting of trees.
1 2 3 4 5	We should all use coal because it is produced in Botswana.
1 2 3 4 5	The best way to cook is on an open fire.
1 2 3 4 5	If we limit the number of livestock, then more trees can grow.
1 2 3 4 5	It's useless to grow crops in Botswana because of drought.
1 2 3 4 5	Only rich people can afford to use new fuel-saving devices.
1 2 3 4 5	Firewood is scarce, expensive and hard to get.
1 2 3 4 5	Cooking with a stove instead of an open fire saves time and money
1 2 3 4 5	Energy doesn't present a serious problem to our family.
1 2 3 4 5	Planning ahead is useless because people don't take fuel shortage as a serious issue.
1 2 3 4 5	Only government, not private individuals, can solve the problem of energy and fuel shortage.

TOWN _____ DATE _____ ENUMERATOR _____ FAMILY NAME _____ NUMBER ___

PROBLEMS IN LIFE

List your 5 most important problems and difficulties in life, number them in order, and state what the solution might be for each problem.

PROBLEM	RANK	SOLUTION
1		
2		
3		
4		
5		

CONCLUSION

What have you learned about energy and fuel use by taking part in this survey?

What suggestions or recommendations do you have for the Botswana Renewable Energy Technology Project so that it can better serve people like yourself?

TOWN_____ DATE_____ENUMERATOR_____ ___FUELWOOD AREA_____

For each fuelwood area which you visit, give a careful description of the area, covering at least the following points.

1 Tree species present in the area, ranked in order of frequency
2 Distance from the town, along what sort of trail or road
3 Types of people who make use of the area, ranked in order of frequency
4 Other uses made of the area e.g. crop farming, cattle herding
5 Rough assessment of the relative abundance of fuelwood in the area
6 Restrictions placed on the use of fuelwood from the area
7 Numbers of people from the different types who use the area at least weekly
8 Types of transport which are used to bring wood from the area, ranked in order of frequency
9 Tools used for cutting wood, ranked in order of frequency
10 Relative proportions of live and dead woodcut in the area for fuel
11 Relative proportions of fuelwood and non-fuelwood in the area
12 Other uses of live and/or dead wood from the area