National Domestic Energy Use Database as a Tool for Integrated Energy Planning

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Abstract

This report is on a project that evolved out of a need for a data resource to provide the necessary background information for an energy policy formulation process particularly concerning the historically disadvantaged South Africans. The project attempts to establish a *National Domestic Energy Use Database* system that could provide a comprehensive collection of available research that has been done in South Africa on low-income household energy usage and related indicators in a consistent format. The goal was to enhance access to key quantitative data, already existing in different forms, for planning purposes.

Whilst the first phase of this project was limited to desktop design, this report is on the second phase which sought to place the database system in an institutional framework that could balance national economic goals with the social needs of the people. Thus, the report briefly describes attempts made to transfer the database system and its data into the public domain by making the Department of Minerals and Energy (DME) the official custodian of the system and establishing a data query mechanism on a web site. The project also seeks to fill the gaps in quantitative, bibliographic and review data by extracting such data manually from the available studies into the database. The development of the energy database in a process of integrated energy planning has been sketched. The development of a more user-friendly interface and an online data analysis of the database are also illustrated. This was to facilitate the utilisation of the system in the public domain. The design of the database is practically demonstrated by capturing existing secondary and primary data on energy use in low-income households in South Africa. Furthermore, the data has been extensively analysed and synthesised to show the factors that influence energy demand in the low-income households and how these factors may interact with one another. It also explores ways of standardising domestic energy data collection on a national basis in South Africa.

Acknowledgement

My thanks are due to the South African Department of Minerals and Energy (DME) for providing the necessary funding for establishing the energy database for the domestic sector, especially the low-income households. The efforts of Mr Tony Golding and Ms Molatelo Montwedi, both of the DME, in guiding this project are very much appreciated. I am also grateful to Ms Wendy Annecke of EDRC for her useful comments on the project. This work would have been worthless without the meticulous data inputting by researchers at EDRC. To all those who helped I am most grateful, especially, Ms Nomawethu Qase. I am also thankful to the Mason-Jones brothers (Craig & Neil) of the Lateral Alternative Computer Consultancy for all the computer assistance in the design of the database and the web site.

Finally, it is my sincere desire that this study could help lay a foundation for understanding the plight of millions of disadvantaged South African households in their quest for access to basic energy services. To these poor households I am deeply indebted for gaining insight into their livelihoods. I hope that the purpose of this study would be greatly served if their lot could be improved and their access to basic energy services could receive some prominence in national energy policy-making.

EXECUTIVE SUMMARY

Introduction

The National Domestic Energy Use Database System evolved out of a need for a data resource to provide the necessary background information for the Energy Policy Research and Training (EPRET) project undertaken by the Energy and Development Research Centre (EDRC), University of Cape Town, in 1992/93. In an effort to initiate debates around major energy use issues to prepare South Africa towards democratic form of government, it was realised, during the EPRET project, that decisions concerning energy provision to the historically disadvantaged low-income households could involve investments in large projects which may have long-lasting impacts on the country. These impacts may not only be on the energy sector but also on the entire economy, including social and environmental costs. Informed decisions needed to be made in order to avoid unnecessary high financial and opportunity costs in energy planning. A project was therefore funded by the then Department of Minerals and Energy Affairs (DMEA) to develop a National Domestic Energy Use Database (NDEUD) System that could combine existing data for identifying research gaps and providing the necessary building blocks of information required for energy planning purposes, especially in the low-income household sector where there had been a great lack of organised data both qualitatively and quantitatively.

This project is the second phase of the development of the domestic energy use database system. The database has been developed alongside actual policy research at EDRC, influencing and being influenced by the other tasks of integrated energy planning. The project attempts to provide a comprehensive collection of all research that has been done in South Africa on low-income household energy usage and related indicators in a consistent format, and to provide quick access to key quantitative data in the studies necessary for planning purposes. Whilst the first phase was limited to desktop design, this second phase sought to place the database system in an institutional framework that could balance national economic goals with the social needs of the people. The main objectives of the second phase of the NDEUD project were as follows:

1. Transferring the database system and its data into the public domain by making the Department of Minerals and Energy (DME) the official custodian of the system.
2. Filling the gaps in quantitative, bibliographic and review data by extracting such data manually from the available studies into the database.
3. Providing database maintenance service in the development and utilisation of the system in the public domain.
4. Expanding the system to include primary data and increasing the level of integration of the individual household records with the other components of the database.
5. Establishing relationships between domestic energy demand factors and socio-economic characteristics of households through data synthesis and analysis.
6. Exploring ways of standardising domestic energy data collection.

7. Exploring possible linkages with other national energy information efforts.

Institutionalisation of the database

With the provision of an appropriate institutional set up a systematic data collection programme could be established for upgrading the information in the database system periodically. Unless this is done the database could outlive its relevance. However, The use of the DME as the main institution for the dissemination of the database system as envisaged in the original contract for this project did not prove very successful throughout the duration of the project. The main reason for this was the lack of institutional capacity to carry out this function. This led to a situation where EDRC had to undertake the dissemination function as well. This affected the project time immensely since such dissemination work was offered as a service at no cost. Apart from the DME, the data from the database and the database itself were disseminated to academic institutions, Non Governmental Organisations and energy supply institutions. Furthermore, there was some dissemination through academic thesis and paper publication.

With the growth of the Internet, we recognised the potential to solve the distribution and update problems of the NDEUD. Thus, the Internet was explored as a means for disseminating the NDEUD system to potential users during the latter stage of the project. The data analysis options in the user-interface of the database system could now be made available on-line through a web site. In this way, access to the data in the system would not be limited to only those users who are well equipped in terms of facilities and training but rather would be opened to all potential users who have access to the Internet. By establishing an online interface and query mechanism to the NDEUD database, it is be possible to update it from a single site, and users can access it without requiring more than a browser and an Internet connection.

The DME agreed in principle to the idea of NDEUD web site on condition that it would not be made party to any costs incurred. The development of the web site is now complete together with all the query mechanisms linked to the database. The web site is still based at the EDRC offices at the time of writing this report and its address is:

http://yaw-afrane.eri.uct.ac.za

Database maintenance

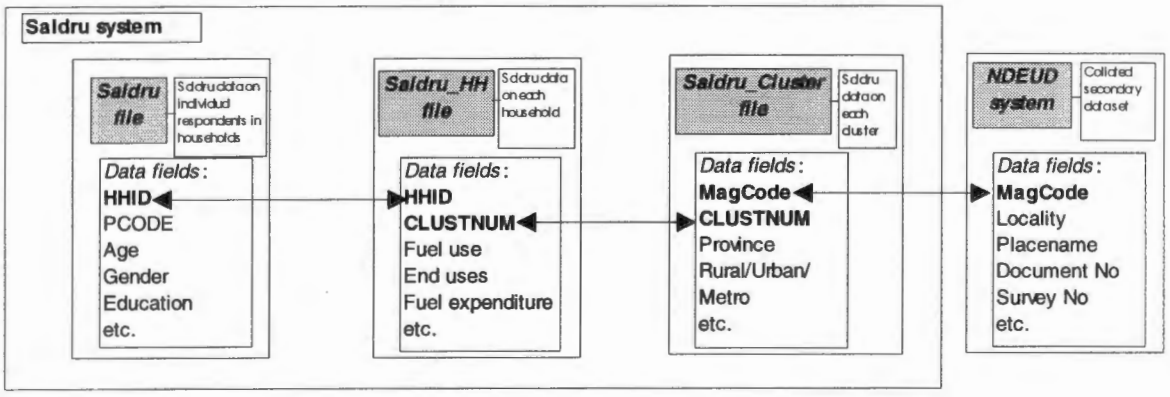
The database maintenance involved the re-designing of the framework of the database and all the linkages between the components of the system periodically to provide the required user-friendliness of the system. The structure of the main components of the database system has been laid out and a more technical detail has been described in a separate addendum to this report.

The updating of the data in the database system occasionally resulted in the corruption of the system and this had to be fixed from time to time. New data were sometimes incompatible with the formats of the data fields in the system. The system design therefore had to be adjusted to accommodate all useful fields of data. The design of the analysis portion of the database user-interface often encountered some maintenance problems since some data entries could not be selected by some queries depending on

the format of the data available. Some of these changes were sometimes purely technical computer programming and as such required some external expertise.

The database system consists of three Microsoft Access database files, namely NDEUD.MDB, ENGDATA.MDB and SALDRU.MDB. The NDEUD.MDB file contains the programme objects and various lookup objects required for running the whole National Domestic Energy Use Database (NDEUD) system. These objects are tables, queries, forms, reports, macros and modules which form the backbone of the system, managing the data sets in the system. The actual secondary energy and energy–related data that has been collated from various household energy study reports is contained in the ENGDATA.MDB file. The SALDRU.MDB file contains a separate primary data set that has been extracted from a national household survey co-ordinated by the South African Labour and Development Research Unit (SALDRU) for the World Bank in 1993/94.

In the database, the Saldru data set has been grouped into three tables, namely *Saldru*, *Saldru_HH* and *Saldru_Cluster*. The Saldru table contains data collected on individual household respondents. The key fields for this table are the HHID that identifies each household and the PCODE that identifies each respondent in the household. The Saldru_HH table contains information unique to each household. The key fields for this table are the HHID, which is the unique identification number for each household, and CLUSTNUM, which is the cluster to which the particular household belongs. The Saldru_Cluster table contains information about each cluster. The key field for this table is CLUSTNUM, which is the unique cluster number. In this table there is also magisterial district code, MagCode, which links Magisterial District field to the Locality table in NDEUD.MDB file to provide locality for the cluster, and hence for each household in the Saldru system as shown below.



The *NDEUD system* constitutes that which pulls together all the secondary data extracted from the various documents/reports on energy studies all over South Africa. In essence, it is the ENGDATA.MDB data file managed by the programme file NDEUD.MDB. Data aggregation from this system has been made possible through the design of a *Data Wizard* that serves as a primary query mechanism for the database. The Data Wizard is a short programme that leads the user step-by-step through the data selection process for building up queries from the database system. The wizard can organise the output of the

data aggregation in four formats namely query, report, Geographic Information System (GIS) and Structured Query Language (SQL).

The *Saldru system* constitutes that which pulls together the energy use and related data extracted from the Saldru/World Bank national survey in 1993/94. It functions in the database system as the SALDRU.MDB data file managed by the programme file NDEUD.MDB. Data aggregation from the Saldru system is provided through the application of a *Saldru Wizard*. The Saldru Wizard works on similar principles as the Data Wizard with few modifications. Unlike the NDEUD system whose data resolution is from the national to locality level, the Saldru system is permitted only up to the Magisterial District level since the raw data was collected at that level.

There is an on-line help facility provided in the system. Wherever one is in the system, the help system is invoked when the keyboard function F1 on the computer is pressed. Like most Windows-based on-line help facility, help topics are linked to facilitate understanding of related issues. However, this facility does not provide deeper understanding of the system and would require further development.

Database enrichment

The focus of this task in this project was more on the improvement of the quality of data in the database rather than on the quantity of data. Even though some documents had been entered into the database, not all important survey data in the documents had been captured. This was usually due to clarifications required concerning the way certain data had been presented in reports. A lot of effort was spent on capturing useful data originally left out in some documents that had already been entered into the database, thus filling in the necessary gaps.

The conversion of the database from one software version to another also created zero data values in certain data fields where data was non-existent. Such errors resulted in distorted picture in the output of analysed data. Therefore some effort was also spent on the cleaning up of such errors in the database.

The *review* and *bibliographic* components of the database itself attempt to review in detail the sources of the secondary data in the database. However, an attempt has been made to briefly summarise the types of studies from which data were extracted into the database, and also, a general observation of the studies, especially the constraints in capturing data from all the different sources of data into one database.

Database expansion

In the first phase of the project no primary data set was linked to the secondary data set in such a way that data from it could be analysed in the user-interface. During this second phase of the project the system was expanded to include a primary data set from the World Bank/SALDRU study on poverty statistics and standard of living which was conducted in 1993/94. This data set comprises almost 9000 household records in about 180 magisterial districts covering all provinces in South Africa. Only the data fields relevant to domestic energy use were extracted into the system.

In addition, the system was expanded to include a facility that creates a Point Attribute Table (a PAT file) for displaying analysed data in Geographic Information System (GIS)

package like ArcView. This is not a live-link of the database to the GIS but a temporary GIS PAT file that gets created any time analysed data is exported into a GIS output. These temporary PAT files have been used to create permanent shapefiles that are further used to create ArcView displays at provincial level and magisterial district level.

The database system was expanded to include the design of an on-line database query mechanism for the NDEUD web site development. Both primary and secondary data sets have now been decoded and can be queried through a query mechanism that runs in Microsoft Access at the background of the web site. This query includes a selection of the required data categories and fields, and the ability to specify restrictions on the data the user is interested in.

This site should be viewed with Netscape Navigator 3.0, or Microsoft Internet Explorer 3.0, 800 x 600 pixel graphics mode (or later versions). The site begins with a basic welcome page, and the user should select *online*, to view the on-line database query system. Basic instructions concerning how to proceed with a query are also provided. The user can specify the category of data and fields required. For example, "Percentage of households using fuels" can be chosen as a category and the data fields that can be selected in this category are *wood, paraffin, electricity, coal, etc.* A set of restrictions can then be set against the data extraction if desired, for example, data for rural dwellings alone.

The first phase of the web site was completed with a free run Netscape FastTrack Server. The server runs off a 133MHz Pentium computer based at the Energy & Development Research Centre. For this purpose, a web server software would have to be eventually obtained and the DME would have to consider running the server off its own computer. Further development of the web site envisaged were online generation of graphs and the incorporation of GIS facility but these could not be accomplished.

Data analysis and synthesis

Although the user-interface of the database system provides a facility for aggregating data for analytical purposes, it has its limitations in terms of variations in analysis and synthesis. One main output of the project was the extensive analysis and synthesis of the data in the database to establish whether there are some relationships between energy demand factors of the household sector and socio-economic characteristics of the household. This also helps to identify where the basic energy needs are in the various geographic locations and where data gaps require critical attention. To simplify the data presentation in this report, most of the data for the analysis have been drawn from the primary data component of the database since this had a national coverage and a common methodology. Whilst the secondary data set mainly covers low-income households, the primary data set involves households at all income levels. For a meaningful analysis in the case of the secondary data set, it often requires extensive consideration of the background of the data sources as well. Thus, in spite of its slight bias towards formal houses, the primary data set offers useful indicators for tracking change in the whole new South Africa.

The data analysis shows that the primary data set is not far from the realities in terms of urbanisation and racial groups in the country. It also shows that the racial groupings to which households belong have had great influence on where people live and the extent

to which they are urbanised. This has emanated from the racial segregation policy under the erstwhile apartheid government that has obviously had an impact on the access of households from different racial backgrounds to energy resources and services. For example, whilst 96% of rural dwellers are Africans, only about 3% of rural dwellers are Whites. Whilst Coloureds and Indians are largely almost equally distributed in metropolitan and urban areas, majority of Whites dwell in the metropolitan areas.

It is important to bear the income inequalities in mind when analysing energy demand and supply factors. It is clear from the study that the South African society has a very slim middle income group (about 15% for the total population according the definitions in this study) compared with the lower income group (about 53%). However, the high incomes of a minority of the population in the higher income group (about a third of the population) distort the overall income per capita picture. Energy policy formulation must address these inequalities, and energy service provision must incorporate the necessary policy instruments that deal with the inherent affordability issues.

Another striking thing noticed in the study is the extent of multiple fuel use phenomenon in the whole country and the analysis points out the communities, the geographic locations and the income group brackets in which it is more of a norm than an exception. Whilst over 50% of the households in the areas of the former provinces use a single fuel for their energy needs, about 95% of the households in the former homeland areas use 2 or more fuels for their needs. Similar observations are also distinguished between rural, urban and metropolitan areas and it is made clear that the provision of a single fuel like electricity to poor households may not necessarily meet their basic needs. For the end uses that are energy intensive, poor households often prefer to use other fuels which they find affordable regardless of the cleanliness or quality of the fuel.

The data synthesis and analysis help to quantify what fuels the poor use and how much they spend on the fuels. The study shows that fuelwood, paraffin, and candles are clearly the fuels of the poor and that as income improves households tend to stop using these fuels. Whilst electricity is shown as fuel of those better off, liquefied petroleum gas (LPG), coal and car batteries are shown as fuels of a small minority. In the delivery of energy services to low-income households, this type of information could help in drawing up policies for subsidy provision and the setting up of selection criteria, especially in the case of electrification. The data analysis also gives a lot of insight into issues of low-income households like electrification and its affordability, total fuel expenditure by households, wood collection, energy end-uses, household income and demographics. It also lays out factors that affect energy use in the low-income households and this can help bring the status of the low-income households into the national development picture in terms of energy provision.

Standardisation of energy use data collection

The standardisation of energy use data collection was looked at in terms of a national objective for updating the data in the energy database in a properly structured manner. Up until now, the data in the database does not come from a common, uniform source, where data is known to be current and accurate. Dissimilar research methodologies, differing surveys during different periods of time, and the lack of national coverage in terms of data collection have hindered effective coherent study of the energy use

patterns of the domestic sector. Since the data is not periodically updated within a national framework, the information available becomes less and less relevant and it does not adequately inform energy policy-making and planning.

A single, unified national approach to energy use data gathering is required to identify where the needs are and the strategic interventions that are feasible. The data must be gathered on a specified periodic basis in a basic standard form so that it can be easily used for updating the database. Although this approach has been presented to the DME several times during the period of the project, enough support was not forthcoming for it to be initiated. A standard questionnaire for the purpose of periodic national data capture is recommended in this regard. In this way, the information derived from the database can be compared over time and the resulting analysis could reflect current situation.

To achieve this, two main strategic options emerged. One strategy is to optimise the opportunities already available in the October Household Survey of the Statistics South Africa (SSA) to capture the basic information required on a national basis. Another strategy is to explore domestic energy use data gathering by grassroots participation. The data collected in the second strategy could be detailed enough to fill the gaps in that collected by the SSA. The intention here is to use the services of the development officers of the local councils for gathering energy use data in the households as part of their usual responsibilities. Since these officials are in touch with the communities, they invariably have the trust of the people and are au-fait with the socio-economic conditions of the localities. They therefore represent a valuable data-gathering resource that could be harnessed. In return, the local councils could benefit from a feedback in the form of an Energy Use Report for their particular locality, which could be a valuable document for informing and assisting the councils in their energy planning at the community level.

When a pilot phase of the grassroots data gathering becomes feasible, a long-term implementation of this could be the establishment of a central Energy Information Centre at the national level. This centre could co-ordinate and administer the periodic energy data gathering and capture the data into a central database for dissemination to policy makers both at the national and community level. This database could be an online system (like the NDEUD web site) that can be queried by those with access to the Internet world-wide. Besides, the centre could provide printed reports to the participating localities, comparing their energy use patterns with national goals and objectives. In this way, those without access to the Internet would still have the necessary feedback. Policy recommendations could evolve out of such reports. The centre could become a one-stop on-line shop for domestic energy information in the country. The information provided would be more reliable and extensive since the databases would be updated periodically by the data captured at the grassroots level.

Conclusions and recommendations

This project has pulled together data on household energy use into a common database that allows a deeper understanding of the basic energy needs of people, especially low-income households. It utilises the integrated energy planning approach that allows all the energy issues of the household, as well as other sectors, to be brought into a common

system for effective analysis of the problems in order to evolve appropriate solutions. Besides linking together already aggregated data that were scattered in various reports, the database system has been expanded to include individual household records that were available in electronic format. It consists of a broad range of data on energy use and energy-related information assembled in a user-friendly Microsoft Access database. This standalone system has been expanded to yield query outputs that can be viewed in a Geographic Information System (GIS) format. This system has been continuously maintained at EDRC and subsequently transferred to the DME.

It has been demonstrated in this report that the National Domestic Energy Use Database (NDEUD) system contains useful organised data that can be periodically updated in a structured manner to provide a wealth of valuable information for energy researchers, planners and policy-makers in South Africa. The outputs of the extensive data analysis carried out during this project clearly illustrate how such a resource can facilitate the identification of the basic energy needs in the various geographic locations. Some of the factors influencing these energy needs of the poor are also analysed and the outputs could provide some direction in policy-making and implementation.

Lessons and recommendations ensuing from the extensive analysis have been detailed in the report. A web site has been establised for querying energy use data online but this would require further development. A structured periodic way of updating the data should also be establised.

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1.
Introduction

1.1 Background

The *National Domestic Energy Use Database System* evolved out of a need for a data resource to provide the necessary background information for the Energy Policy Research and Training (EPRET) project undertaken by the Energy and Development Research Centre (EDRC), University of Cape Town, in 1992/93. In an effort to initiate debates around major energy use issues to prepare South Africa towards democratic form of government, it was realised, during the EPRET project, that decisions concerning energy provision to the historically disadvantaged low-income households could involve investments in large projects which may have long-lasting impacts on the country. These impacts may not only be on the energy sector but also on the entire economy, including social and environmental costs. Informed decisions needed to be made in order to avoid unnecessary high financial and opportunity costs in energy planning. A project was therefore funded by the then Department of Minerals and Energy Affairs (DMEA) to develop a National Domestic Energy Use Database (NDEUD) System that could combine existing data for identifying research gaps and providing the necessary building blocks of information required for energy planning purposes, especially in the low-income household sector where there had been a great lack of organised data both qualitatively and quantitatively.

The first phase of the project has been reported on by Trollip (1994). During this first phase of the project, the database system was successfully constructed and it was designed to be consistent and compliant with the principles of Integrated Energy Planning (IEP). Thus the system was developed to capture all relevant energy use issues in the domestic sector required for analysis within a unified framework in order to arrive at a set of national goals over a period of time. However, it was realised that the database system was unlikely to be widely used if it was not adequately serviced and disseminated. There were a lot of data gaps needed to be filled and the system required an institutional setting and support to ensure that there is continuous maintenance and update of the system. The system itself required a lot of improvement and expansion to include other sources of data that become available with time in order to meet the changing needs of users.

This report is on the second phase of the project which has been mainly funded by the Department of Minerals and Energy (DME), although Eskom supported an aspect of it at one stage. The database has been developed alongside actual policy research at EDRC, influencing and being influenced by the other tasks of IEP. The project attempts to provide a comprehensive collection of all research that has been done in South Africa on low-income household energy usage and related indicators in a consistent format, and to provide quick access to key quantitative data in the studies necessary for planning purposes. In this way, key national research gaps are identified.

The second phase of the development of the domestic energy use database system was a three-year project which was started in September 1995. This second phase

sought to place the database system in an institutional framework that could balance national economic goals with the social needs of the people. To achieve this, the project was aimed at transferring the system into the public domain by making the Department of Minerals and Energy (DME) the official custodian of the system, the DME increasingly taking up the role of dissemination while EDRC continued with further development of the system.

1.2 Project objectives

The main objectives of the second phase of the NDEUD project were as follows:

2. ***Institutionalisation of the database:*** Energy planning and policy work need to be situated in an institutional framework that can balance national economic and development goals, the needs of energy consumers and the capacities of energy suppliers. This function can be explicitly defined and resourced if the database system could be placed in an appropriate public domain that could provide the required institutional capacity for its effective development and dissemination. The project was therefore aimed at making the DME become the official custodian of the database, responsible for co-ordinating and overseeing maintenance actions that are necessary. This task was also meant to involve the operational requirements and dissemination. Prospective users could be identified by the department and subsequently informed of the existence of the database system, trained and supported in its use. In this project objective, the DME was purposed to co-ordinate all training needs of users, maintenance requests and user feedback while EDRC would be responsible for taking all necessary actions on training, maintenance and feedback, within the constraints of the project.

3. ***Data enrichment.*** At the end of the first phase, even though the database system had extensive coverage of many fields and studies, there were still many data gaps that needed to be filled. Much work had to be done in gathering bibliographic and review data from the available studies into the database, in addition to the large portion of quantitative data that was still remaining in the various reports. Data gathering manually from reports on energy studies by different researchers with different methodologies also posed a great challenge. The first phase of this database development was not adequately funded to provide effective data entry into the system. However, the data gathering from the reports and its capturing into the system should be obviously one of the most critical specialised function since any serious errors in this function could easily jeopardise the whole noble purpose of energy planning. Already, institutions like Eskom and the DME had spent huge sums of money on domestic energy use studies in recent years. The project therefore purposed to put some effort into extracting the necessary data from the reports on those studies into an organised format in the database in order to make such a huge investment useful.

4. ***Database maintenance.*** It is important to note that energy data is not an end in itself but is collected essentially for use in energy planning (APDC 1985). As the database was transferred into the public domain it would certainly require some regular maintenance in order to meet the needs of different users and at the same time keep the data up-to-date. One of the main objectives of the project therefore was to provide this database maintenance service in the development and utilisation of the system. Effective database maintenance was aimed at keeping data integrity intact by incorporation of the necessary validation rules so

that searches could pick up all relevant records and to ensure that data was entered correctly. Sufficient user-friendliness also needed to be incorporated into the system if it was to remain useful effectively in the public domain. Thus the project purposed to provide some simple user help online as well as a user guide in the form of a basic user manual that gives a simple description of the technical structure of the database.

5. ***Database system expansion.*** Although, at the end of the first phase, the data and field names in the primary data sets comprising individual household records had been largely transformed into a form accessible to users, the data remained inadequately useful for integration with the other components of the database system since much of it were in some form of codes. This project therefore sought to increase the level of integration of the individual household records with the other components of the database. One objective of the project was to expand the system to include primary data on the Project for Statistics on Living Standards and Development (SALDRU 1994) and establish the appropriate linkage with the database in electronic form so that the database system could aggregate data from this primary data source. It was also purposed to expand the system to include some linkage that could enable the transformation of the output of data analysis into a Geographic Information System (GIS) view.

6. ***Data analysis and synthesis***. The iterative processes of IEP are usually sieved through analysis and synthesis of data to demonstrate the power of the database in supporting policy-making. To achieve this, one of the project objectives was to construct data queries that could yield aggregate data reports on different basis and levels of data in order to provide statistical estimates from the existing data. This was to be built up progressively and iteratively to paint more detailed quantitative pictures of energy usage patterns and how they relate to household socio-economic characteristics. Some conversion facilities in terms of survey dates, currency values, energy units, etc., were also to be provided at all levels of data to enhance data analysis and synthesis. In this way, the relationships between domestic energy demand factors and socio-economic characteristics of households could be established for policy formulation. Household energy policy could thus be informed by such relationships in order to enhance its effectiveness in implementation.

7. ***Standardisation of domestic energy data collection***. In the past, the collection of domestic energy use data was undertaken in a very fragmented way in South Africa with different methodologies and measurements. Evidently, that approach not only entailed much duplication of effort and waste of resources, but also more importantly, by lacking standard definition of the common data entities collected, resulted in incompatible data sets. As part of this project, therefore, it was proposed that all questionnaires used for domestic energy data collection be pulled together and standardised, with common entities accorded standard definitions. It was envisaged that this could allow the decentralised collection of data, the establishment of many application specific databases, while maintaining the possibility of aggregating or correlating such data consistently with that generated by other efforts. It was thus envisaged that this project would be informed of all national efforts in domestic energy data collection and made part of the co-ordination of such efforts in order to ensure proper sampling coverage and standard methodology and measurements.

8. It is worth-mentioning that one of the initial objectives of the project was to create the necessary linkage with the National Energy Information System (NEIS) at the Rand Afrikaans University and the then proposed central database for the Reconstruction and Development Programme (RDP). However, from the onset of the project, it was found that this objective could not be pursued because (1) the envisaged RDP database did not become a reality as thought and (2) the format of the NEIS data and the data requirements could not be adequately fulfilled by the data already gathered by the NDEUD project.

1.3 Project outputs

The various outputs of the project have been laid out in detail in subsequent chapters with clear descriptions of the methodologies used when necessary. An attempt is made to summarise these outputs in this section.

A user-friendly computerised database system has been designed and it comprises a number of data categories that are relevant to integrated energy planning for the low-income household sector. The database components hold large volumes of data on energy usage and other socio-econo-demographic and housing information. The system further aggregates data from secondary and primary sources on different levels of geographic locality. The data aggregation facility in the database system has a Geographic Information System (GIS) output which can be viewed with a GIS package like ArcView. Attempts have been made to put the system in the public domain, by possibly making the DME the official custodian, to enhance policy formulation that would ensure better energy provision for the poor. A framework has been designed to undertake the continuous maintenance of the system, its expansion and updating, and to rationalise energy usage and related data collection in the household sector.

In the first year of the project, as part of the institutionalisation task, the database was installed at the Department of Minerals and Energy (DME). The aim was that the DME would increasingly take up the role of dissemination while the Energy & Development Research Centre (EDRC) continues with further development of the system. Due to lack of capacity and the lack of both software and hardware requirements at the DME this has not been very successful. The strategy during the latter stages of the project therefore was changed into the provision of a web site for the purpose of dissemination of information from the database. As part of the database system expansion task, the database system was therefore expanded to include an on-line query mechanism for the web site.

During the second year of this project *on National Domestic Energy Use Database as a Tool for Integrated Energy Planning* emphasis was placed on the task involving the synthesis and analysis of the data in the database. The reason was to derive information from the data that had been assembled and organised in the database as a feedback to energy policy makers and planners. In the previous year of the project, the data analysis and synthesis task was mainly limited to the design of mechanisms for querying the data in the user-interface according to selected categories of data. Although these query mechanisms in the database system provide the ordinary user with a friendly approach for basic analysis of the data without the need for knowledge about the software, they have their limitations. The range of cross tabulations possible in the analysis of the data is limited in the user-friendly query mechanisms in the user-interface of the system. During second and part of the third

years of the project, however, extensive synthesis and analysis of the data beyond the user-interface were carried out in Chapter Six of this report.

The data enrichment task continued throughout the project with data gathering manually from reports on energy use studies, although much emphasis was placed on data quality this time. The quality and quantity of information derived from the database system largely depended on the effectiveness of this task, yet there was often financial constraints in getting this task done properly. Thus efforts were made to shift from the short-term recruitment of data entry staff to effective capacity building in this area of work. However, this was not very successful due to financial constraints since funding could only be provided for short-term data entry.

The conversion of the database system from a Microsoft Access Version 1 to Version 2 in the Windows 3.1 environment, and later on to a Windows 95 environment required frequent database maintenance. The development of the query mechanisms for both the database user-interface and the web site all required some database maintenance. Furthermore, the data entry process occasionally corrupted the system and database maintenance actions were necessary.

Lastly, the task of standardising energy use data collection took a different turn from what it was initially envisaged since the required co-operation was not forthcoming. New strategies evolved for a structured way of collecting data periodically for updating the database. These strategies were proposed in the progress report of the second year of the project for possible implementation in the last year of the project. It was hoped that a standard questionnaire could emerge out of the process but funding was not available for a pilot project of the strategies. However, it is hoped that strategies laid out in this report would be useful in evolving a standardised way of gathering household energy use information periodically.

2.
Institutionalisation of database system

2.1 Dissemination through DME

The National Domestic Energy Use Database (NDEUD) system contains a wealth of valuable information for energy researchers, planners and policy-makers in South Africa. In addition, it can potentially expose the international community to investment opportunities existing in the domestic energy sector. The analysis of the data in the system helps to identify where the basic energy needs are in the various geographic locations and where data gaps require critical attention. However, unless there is a proper institutional framework for the dissemination of the system the energy use information that can be derived from the system would neither get to the users at the grassroots level nor the energy policy-makers and investors. There is a great need of data gathering for updating the system with relevant information. With the provision of an appropriate institutional set up a systematic data collection programme could be established for upgrading the information in the database system periodically. Unless this is done the database would outlive its relevance.

The use of the Department of Minerals and Energy (DME) as the main institution for the dissemination of the database system as envisaged in the original contract for this project did not prove very successful throughout the duration of the project. The main reason for this was mentioned in Chapter 1 as the lack of institutional capacity to carry out this function. This led to a situation where EDRC had to undertake the dissemination function as well. This affected the project time immensely since such dissemination work was a service offered at no cost.

2.2 Initiative to disseminate through a web site.

Another reason why the dissemination function through DME was not successful was that the distribution of the system as a Microsoft Access database presented a number of problems:

- the system is large, requiring both substantial computer drive-space and memory to run adequately;
- it requires a copy of MS-Access software (at least version 2.0) to work properly;
- the user also requires a copy of ArcView to use the Geographic Information Systems (GIS) outputs of the system. The ArcView software itself requires so much memory and disk space to run;
- thus, the distribution of the system is slow and costly, and updating is equally resource-intensive.

These problems made it inaccessible to many potential users except those with resources since the hardware and software requirements for its installation are not easily affordable.

Against this background, the Internet was explored as a means for disseminating the NDEUD system to potential users during the latter stage of the project. The rapid

development of the Internet in recent years opened up a new possibility for the dissemination of the NDEUD system: an on-line presence. The data analysis options in the user-interface of the database system could now be made available on-line through a web site. In this way, access to the data in the system would not be limited to only those users who are well equipped in terms of facilities and training but rather would be opened to all potential users who have access to the Internet.

The DME agreed in principle to the idea of NDEUD web site on condition that it would not be made party to any costs incurred. The development of the web site is now complete together with all the query mechanisms linked to the database (see Chapter 5). The web site is based at the EDRC offices and its address is:

http://yaw-afrane.eri.uct.ac.za

With the growth of the Internet, we recognised the potential to solve the distribution and update problems of the NDEUD. Through the Internet access to information in the database could be widened to a much broader audience than had been possible using custom developed software. By establishing an online interface and query mechanism to the NDEUD database, it would be possible to update it from a single site, and allow users to access it without requiring more than a browser and an internet connection.

Features of the online system

Operation of the NDEUD Online web site is as follows:

1. Users select a broad category of data that they wish to query.
2. The resolution, fields to be included in the result set, and restrictions on the included data are specified through the web interface, using a simple logical language.
3. Output appears in HTML with full bibliographic information detailing the documents from which the output data was generated.
4. The output can be obtained in text, comma-delimited format allowing easy export into spreadsheet applications.

Examples of outputs of data query from the web site have been shown in Chapter 5. Because the site is maintained as a single web site, maintenance is centralised and it is possible to add additional information and research results to the site. Furthermore, one could also download the Microsoft Access version from the web site. The downloaded version of the database would be in a compressed format and one could decompress it and run it on one's own computer.

Administration

Although at the moment the data contained in the NDEUD database is not completely up-to-date, the system has been designed to be **maximally extensible**. New fields, restrictions and categories can be added from a form-based administration in the database, and the web interface would be immediately updated to reflect these additions. In future it would be necessary for the web site to be moved to a DME computer so that the department could take control of it and manage it. A simplified technical information for understanding the operation of the *Online Database* has been compiled in an addendum to this report (Addendum 2). The structure of the database has been described in this small manual for the purposes of managing the web site database. This information can also be found online and it

contains all the necessary contact information of the computer designer who put most of the system together.

2.3 Information dissemination to institutions

As mentioned above, the EDRC continued with the system dissemination function of the project. Request for information on domestic energy use came from individuals from organisations like the Paraffin Safety Association, the Environmental Monitoring Unit at the University of Cape Town, the DME and some international institutions, especially in the USA. There have also been requests from Technology & Research Investigations (TRI – Eskom) and some individuals from Eskom Electrification Planning Unit. Analysed information from the database was organised for such requests. Information from the database was also used to support the work being done by some EDRC researchers, for example, projects on Social Determinants of Energy Use in the Western Cape, Rural Electrification and the Energy and Environment programme. Some researchers from the Energy Research Institute (ERI) also expressed interest in using the system. After an introduction of the system to them, the system was given to them under the permission of the DME for installation for their purposes.

2.4 Dissemination through academic work

Extensive analysis of the data in the database has been detailed in a Masters thesis on Domestic Energy Use Database for Integrated Energy Planning (Afrane-Okese 1998a). This thesis report was submitted to the Faculty of Engineering at the University of Cape Town early 1998. Some of the important outputs of the analysis have been described in Chapter Six of this report.

Another dissemination was through a project funded by Technology & Research Investigations (TRI – Eskom). The project used data drawn from the database as input into the Long-range Energy Alternatives Planning (LEAP) model for making energy demand projections for low-income households in South Africa (Afrane-Okese 1996). A paper was written on the energy demand projections that came out of the project and it has been submitted to the *Energy and Sustainable Development Journal* for publication. The title of the paper is *Scenario developing for domestic energy use demand* (Afrane-Okese 1998b).

3.
Database maintenance

This chapter describes the design framework of the database and all the linkages between the components of the system that periodically required some maintenance. The structure of the main components of the database system has been laid out in this chapter and a more technical detail has been described in a separate addendum to this report.

The updating of the data in the database system occasionally resulted in the corruption of the system and this had to be fixed from time to time. New data were sometimes incompatible with the formats of the data fields in the system. The system design therefore had to be adjusted to accommodate all useful fields of data. The design of the analysis portion of the database user-interface often encountered some maintenance problems since some data entries could not be selected by some queries depending on the format of the data available. Some of these changes were sometimes purely technical computer programming and as such required some external expertise.

During the period of the project the database system at EDRC was converted from a Microsoft Access Version 1 to Microsoft Access Version 2 in Windows 3.1 environment and finally into that of Windows '95. There were three main reasons for this:

- **Software advancement.** Windows '95 and its associated software are becoming the norm these days and therefore the system was converted into Access '97 to accommodate all users who might be working in the Windows '95 environment.
- **Efficiency**. The queries in the database system work more efficiently in the Windows '95 environment than that of Windows 3.1, provided the minimum hardware requirements are met.
- **Web site preparation**. It was necessary to determine the final platform for hosting the NDEUD web site at the outset since, once a phase had been completed for the development of the web site based on a particular platform, it would not be possible to switch platforms for a later phase. Windows '95 provided the suitable environment for a Windows-based web server as a platform for a database like the NDEUD that was already in Microsoft Access 2.0.

Initially, the hardware (at least a Pentium) and software (Windows '95 and Microsoft Office '97) requirements were the main constraints in the database conversion into Windows '95; however, EDRC eventually bore the cost involved. The conversion ran into many technical bugs in terms of programming that required extensive database maintenance work.

3.1 The structure of the National Domestic Energy Use Database System

3.1.1 Introduction

The database system consists of three Microsoft Access database files, namely NDEUD.MDB, ENGDATA.MDB and SALDRU.MDB. The NDEUD.MDB file contains the programme *objects* and various lookup *objects* required for running the whole National Domestic Energy Use Database (NDEUD) system. These objects are tables, queries, forms, reports, macros and modules which form the backbone of the system, managing the data sets in the system. The actual *secondary* energy and energy–related data that has been collated from various household energy study reports is contained in the ENGDATA.MDB file. The SALDRU.MDB file contains a separate *primary* data set that has been extracted from a national household survey co-ordinated by the South African Labour and Development Research Unit (SALDRU) for the World Bank (SALDRU 1994).

3.1.2 Collation of existing domestic energy use data

The ENGDATA.MDB file embodies the *National Domestic Energy Use* secondary data set gathered from reports and papers on household energy use studies all over South Africa. It is thus a comprehensive collection of aggregated data already analysed by the respective authors of the various reports. As one would imagine, data collection and analysis of such aggregated data covering several years and different geographic locations in the country would definitely require different research methodologies by the different authors according to the objectives set for each specific study. The extraction of data from such diverse sources into one unifying database requires a broad understanding of the issues at stake and a lot of care has been taken in grouping data items into the appropriate similar fields of information in the database.

The focus of this data set has been mainly low–income households. This is because the supply-side information on high and medium income households has been reasonably reliable whilst information on low–income households remains virtually non-existent, a situation resulting from the total neglect by the previous political dispensation. Furthermore, the development of this data set has been demand–side driven since it was purposed to identify factors for estimating the energy demand of low–income households based on the needs of the people.

The demand for a source of energy is based on the services for which it is required, the extent to which such services are spread among the population and the efficiency with which they can be delivered (Reddy et al 1995). The energy requirement so estimated is then matched with energy–supply and/or energy saving options, so as to minimise costs. Thus, the coverage in this data set extends to all issues like demographics and socio-economics that could directly or indirectly determine the energy requirement by a household in an integrated energy planning process.

There are two sub–components of this data set. For each study that has been identified as having possible relevance to low–income household energy use, there is a provision for a record in the data set consisting of basic bibliographic data and comments on the nature of the study, its objectives and usefulness. If the study was found to have quantitative data relevant to household energy consumption, the data set would then have indications on the kind of information covered by the

quantitative data in that specific study. This sub–component of the data set constitutes the *bibliographic and review database.*

The second sub–component of this data set contains actual survey numerical household energy use data. It is referred to as *aggregate data* because it is invariably presented in reports as tables of averages, across a wide variety of groupings, for quantitative data from individual households. The primary groupings are locality and dwelling type. The locality can be a zone in a township, or a township, or a town or city, or a magisterial district or a province and a distinction is also made between rural and urban localities. Thus, for each study/report, provision is made for any possible number of records for dwelling type/locality combinations. This serves as a link to the groupings for energy usage profiles that also use geographic area and dwelling type as main criteria for aggregation of data. In terms of geographic locality, four levels of data aggregation are possible in the system, namely: national, provincial, magisterial district and locality levels.

Fuel consumption by users: net energy (MJ/month/household)
% households using fuels
Fuel prices (cents/unit of measurement)
Fuel expenditure by all (R/month/ household)
Fuel expenditure by users: (R/month/hh)
Fuel consumption by all: net energy (MJ/month/ household)
Fuel consumption by all: physical quantities (unit/month/ household)
Fuel consumption by users: physical quantities (units/month/hh)
Wood collection (% households)
End uses of fuels - lighting (% household)
End uses of fuels - water heating (% household)
End uses of fuels - space heating (% household)
End uses of fuels - cooking (% household)
Fuel consumption by all: useful energy (MJ/month/ household)
Appliances : planned purchases (% household)
Appliances : purchases (% household)
Appliances : % household ownership
Attitudes to Electricity : priorities of advantage (% household)
Attitudes to Electricity : perceived affordability (% household)
Attitudes to Electricity : payment preference (% household)
Attitudes to Electricity : priorities for appliances (% household)
Employment : employment levels (% household)
Employment : frequency of migration (% household)
Employment : economic sector (% household)
Employment : place of employment (% household)
Services provided (% household)
Services : community priorities (% household)
Services : household priorities (% household)
Socio demographics : education (% respondent)
Socio demog : education (% sampled household)
Socio demographics : age (% household in age group)
Housing
Household Income (R/month)
Household Expenditure (R/month)

Table 3.1: Categories of quantitative data in the form of tables attached to each survey number

These four levels of aggregation of data by geographic location are stored as data fields in the *Locality* table found in the NDEUD.MDB file which can be linked up with

the names of places surveyed (*placename*), provided it can be identified amongst the pre-defined enumerated areas by the Central Statistical Services (recently called Statistics South Africa). Besides the four levels, the data can also be aggregated at the level of the former homelands. The coverage of aggregated quantitative data attached to each survey is very broad. Table 3-1 lists 34 categories of data with wide range of fields for data capturing.

The ENGDATA.MDB database file contains 502 documents out of which over 370 surveys have been identified. It must be pointed out clearly, however, that not all the surveys have the same details of data. Due to the varied objectives and different survey methodologies of the various studies, surveys may have different coverages of data fields and, as a result, not all surveys have data for every data field in the database. The programme file NDEUD.MDB works together with the ENGDATA.MDB data file in the analysis of the quantitative data in the various documents. Such analysis produces aggregated information in the form of reports which can be printed or outputs in the format of Geographic Information System (GIS) which can be displayed in Arcview. The synergy of both the programme and data files, respectively NDEUD.MDB and ENGDATA.MDB, is hereafter referred to as the NDEUD (National Domestic Energy Use Database) system.

3.1.3 Linking of primary energy use data with secondary data set

Like the NDEUD system, the NDEUD.MDB programme file works with the SALDRU data set (SALDRU.MDB file) in a similar fashion to produce the *Saldru system*. However, the Saldru system works with a separate data set of individual *primary* records consisting of about 9 000 households in the form of coded information. The data is stored mainly in its original form as coded information that the Saldru system decodes into meaningful formats in its analysis of the data.

The Saldru data set is an extract from the SALDRU study as mentioned in Section 3.1.1. The study was an attempt to measure a wide range of measures of living standards in South Africa, of which energy was one. Table 3.2 lists the categories of data extracted from the bulk data of the SALDRU study into the Saldru data set that forms part of this database system.

Item	*Category*
1	Household Roster - demographics, gender, relations, etc.
2	Housing - dwelling type, construction, ownership, etc.
3	Sampling frame - locality information
4	Appliance data
5	Household fuel expenditure
6	Household monthly expenditure
7	Fuel end-use - cooking, house heating, water heating, lighting
8	Wood collection
9	Employment status
10	Water and Sanitation
11	Quality of life

Table 3.2: Categories of data in the Saldru data set

Unlike the NDUED system where the various surveys focused on specific localities, the Saldru data set had a national basis with coverage over all the nine new provinces of South Africa. In all, 188 magisterial districts were part of the clusters used for the survey.

In the database, the Saldru data set has been grouped into three tables, namely *Saldru*, *Saldru_HH* and *Saldru_Cluster*. The Saldru table contains data collected on individual household respondents. The key fields for this table are the HHID that identifies each household and the PCODE that identifies each respondent in the household. The Saldru_HH table contains information unique to each household. The key fields for this table are the HHID, which is the unique identification number for each household, and CLUSTNUM, which is the cluster to which the particular household belongs. The Saldru_Cluster table contains information about each cluster. The key field for this table is CLUSTNUM, which is the unique cluster number. In this table there is also magisterial district code, MagCode, which links Magisterial District field to the Locality table in NDEUD.MDB file to provide locality for the cluster, and hence for each household in the Saldru system. Figure 3.1 below illustrates the data fields through which the Saldru system files and the NDEUD system are linked.

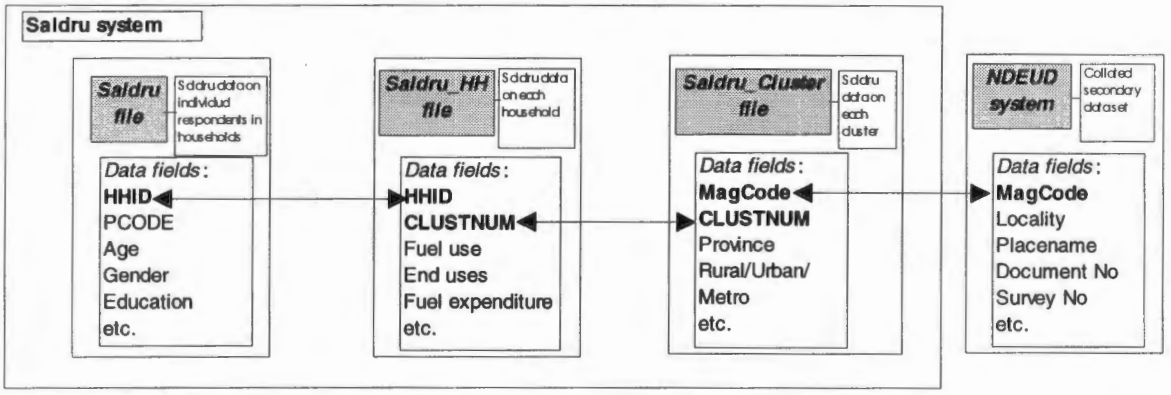


Figure 3.1: Links between the files of the Saldru system and the NDEUD system

3.2 General user-friendly interface of the database

As mentioned earlier on in Chapters 1 and 2, the current phase of the database development was aimed at transferring the system into the public domain. To facilitate the transfer of the system into the appropriate institutional set-up in the public domain, a user-friendly interface had to be provided. The system had to be improved and this improvement was extended to all the necessary requirements for expansion of the system to include the large volume of data from the Saldru studies.

As a first step, the data fields in the system were reviewed to accommodate the changes envisaged. Then the whole system was completely re-designed to enhance the linkage with the Saldru data set. To avoid scrolling through lengthy hidden pages when viewing or capturing data, a multi-paged form design is the approach largely used. Forms with lengthy pages have been broken down into many pages with each page completely visible on the screen. The pages are now easily accessed through mouse clicking on tab controls.

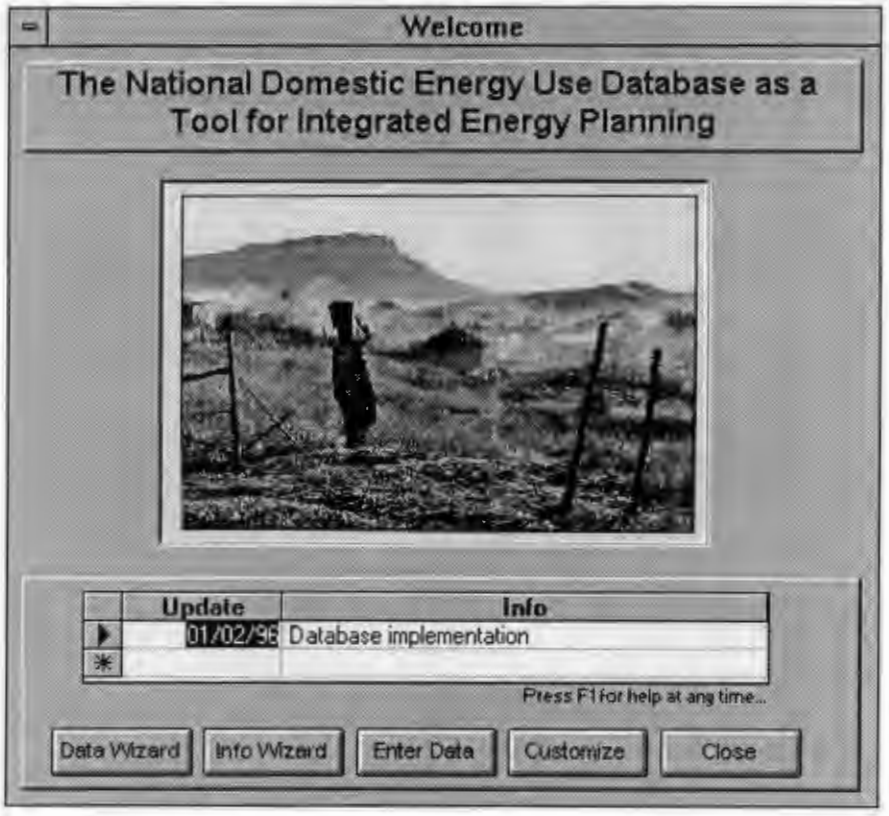


Figure 3.2: The first screen presenting the system[3]

When the database system is loaded up it is introduced to the user as presented in Figure 3.2. The clicking of the mouse on the buttons at the bottom of the figure leads the user to specific tasks. For example, the clicking of the mouse on the *Enter Data* button will lead the user to the data capturing or editing screens of the NDEUD system and also, a presentation of the raw data in that system.

3.2.1 The structure of the data capturing system

The structure of the data entry system for the NDEUD system can be seen in Figure 3.3 below. In this system, it is possible to visualise the linkage between the various documents and the attached surveys. For example, in Figure 3.3, 21 surveys are attached to document *Number 290* which is entitled *Energy Usage in Urban Black Households in Selected Formal and Informal Townships of South Africa,* a study which was undertaken by *Hoets, PA and Golding, AP*. It can also be seen at the bottom of the figure that this document *Number 290* is the 290th record out of 497 records of reports that had been entered at the time of this data entry. Whereas the horizontal arrows at the bottom of the figure allows you to move to any particular document, those in the middle of the figure allow you to scroll through all the surveys attached to the document in view.

[3] The main technical aspects of the database were designed by the Lateral Alternative Consultancy cc, Cape Town.

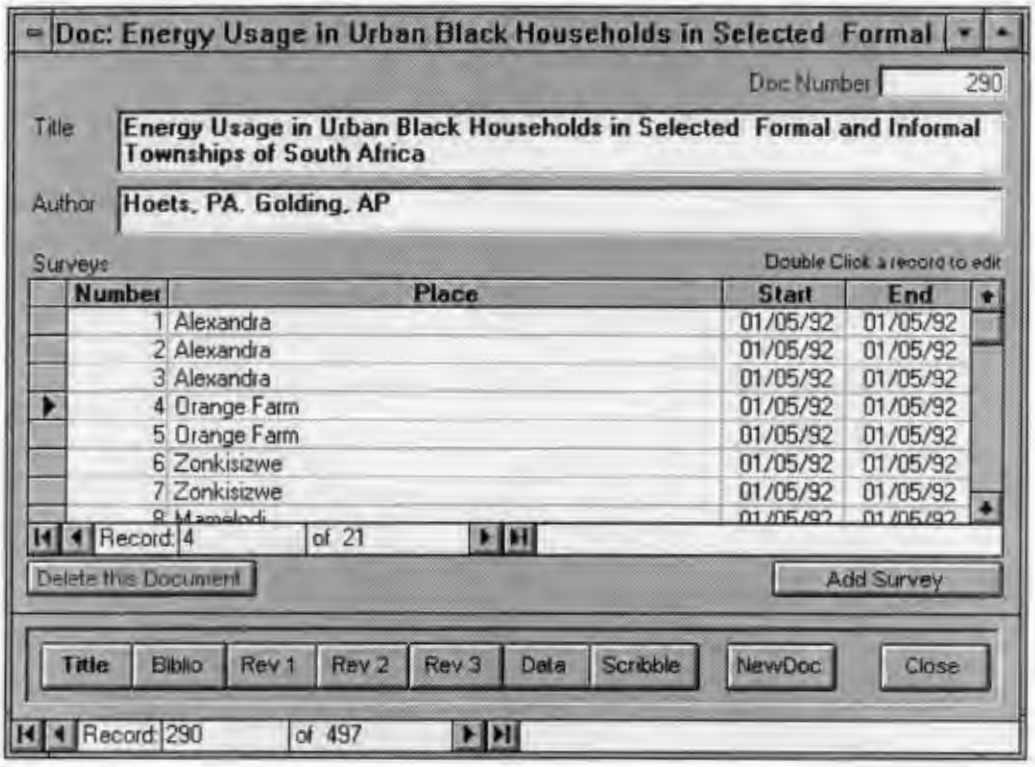


Figure 3.3: The data capturing system

Each of the buttons below the figure above takes you to a different page of information on the selected document by a mouse click. The *Title* button is the default page, which is the one in view. The *Biblio* button takes you to the bibliographic information on the selected document. The *Rev1, Rev2, Rev3* buttons are those three buttons that take you to the three pages of review of the selected documents. The *Scribble* button allows you to enter any comments on a particular document that did not fit anywhere else in the database. The *NewDoc* button creates a completely new form for a new document one intends to add to the system and, in addition, any number of surveys you wish to attach to that particular document can be created at this point. The *Close* button takes you back to the first page of the database system. This screen and all those linked to it also allow editing of data. An unwanted document can be deleted from the system and a new survey can be added to a document.

In the document shown in the above figure, within one single report, 21 surveys were identified, with the difference being the survey place or the dwelling type. A combination of a document number, a survey number, a survey place and a dwelling type uniquely identifies a survey. For example, the triple occurrence of Alexandra as surveys attached to *Document Number 290* in the above figure indicates that there were three dwelling types surveyed, namely; Formal Housing, Planned Shacks and Unplanned Shacks. The linkage between documents and their attached surveys has been illustrated in Figure 3.4. It must be noted that not all documents have surveys attached to them. The emphasis here has been surveys with quantitative data on energy use and consumption.

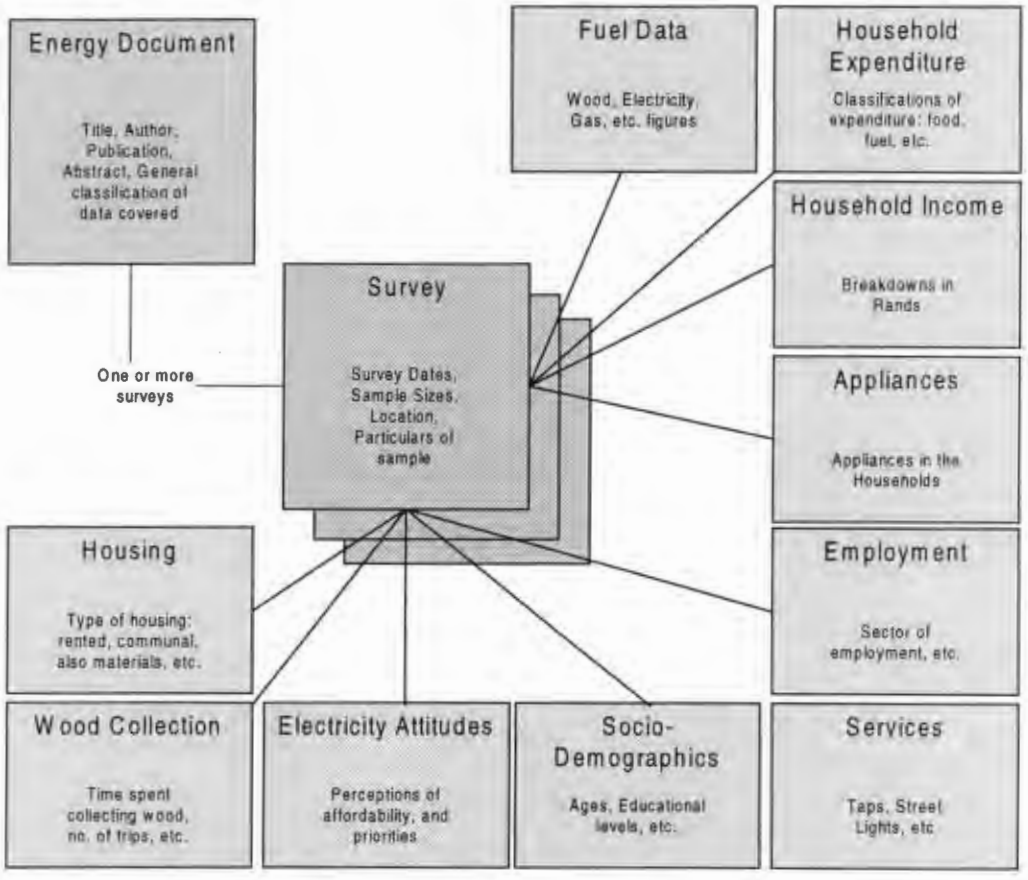


Figure 3.4: Linkage between documents and their attached surveys

3.2.2 Bibliographic and review data

As mentioned in the previous section, the clicking of the *Biblio* button in Figure 3.3 opens up the first screen of the *Bibliographic and review* section of the NDEUD database system. On this screen all the bibliographic information recorded in the particular report or document is extracted and entered into the system for the benefit of the user in ascertaining the background of the data in the system. It also helps in making references to specific documents a user may be interested in checking the details of the background information. It also deals with the extent of electrification, dwelling types and urbanisation issues covered in a particular study. Figure 3.5 shows the *Biblio* screen. It can be seen on this screen that dwelling types covered by surveys attached to *Document 290* are formal housing, planned shacks and unplanned shacks and backyard shacks.

As much as possible, each document has been reviewed and a summary of the review has been entered into the system through buttons *Rev 1, Rev 2*, and *Rev 3*. *Rev 1* stores information on the main objectives of the study, a short abstract of the study and the key recommendations made. Comments are also made on the study as well as short notes to guide the user concerning the usefulness and limitations of the particular study. Other outputs of the study that are useful information related to energy use are also captured by *Rev 2* screen. *Rev 3* also captures information on the survey methodology, statistical information and the location of the study.

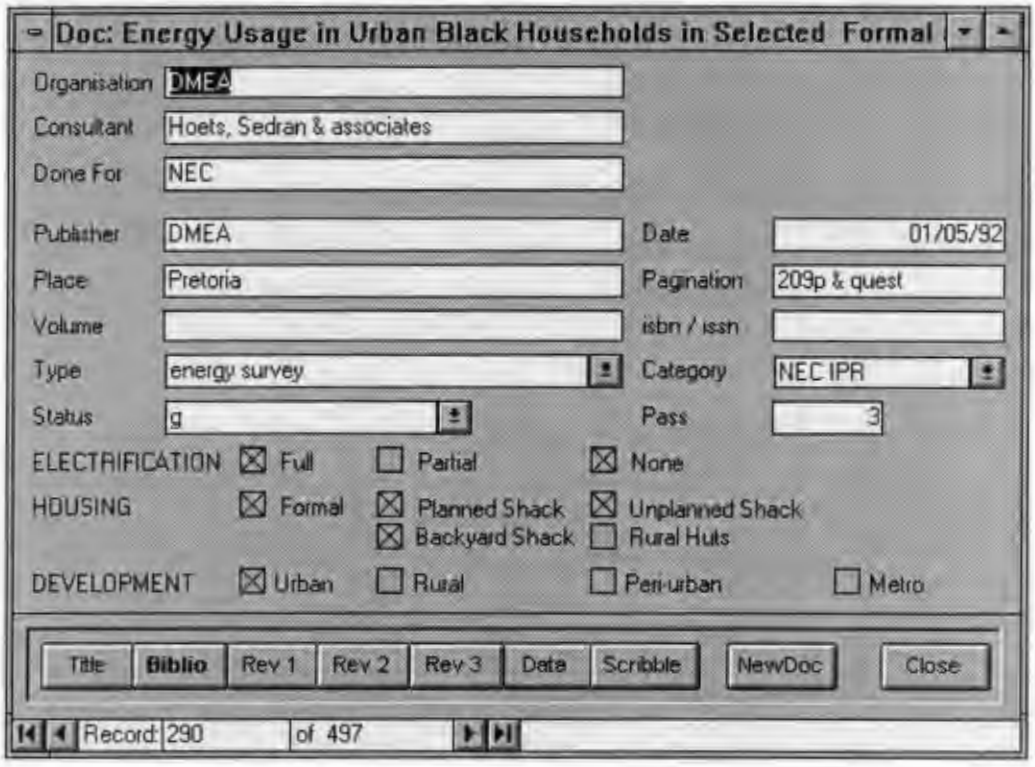


Figure 3.5: The Bibliography screen

3.2.3 Review information on surveys

Editing of the surveys have been made easy by providing immediate access to them the first time they appear with their linked document as in Figure 3.3. For example, double-clicking *Survey 1* of *Document 290* in Figure 3.3 opens up the first screen with review information on this particular survey as shown in Figure 3.6. Whilst buttons *Biblio, Rev 1, Rev 2*, and *Rev 3* cover summarised review of a whole document or report, review information captured on the above screen deals with individual surveys attached to documents.

It captures methodology used for collecting data and also supporting statistical information like *Confidence Level, Sample Size* and *Universe* to show the representativeness of the data collected during the survey. It also captures the level of urbanisation of the sampled households with mutually exclusive choice between *Rural, Urban, Peri-urban* and *Metro*. For the purposes of converting energy expenditures and fuel prices into present worth values the year in which the survey was conducted is captured to indicate which Consumer Price Index (CPI) value is used for the conversion.

In Figure 3.6, both the survey *Place* and the *Locality* fields are Alexandra township. In some cases the survey place and the locality fields have different values showing different levels of data aggregation according to geographic location (e.g. if the survey place were say a small zone in the Alexandra township). This is because there is a pre-defined *Locality Builder* in the database system that categorises all survey places according to the enumerated areas assigned by the Central Statistical Services (CSS).

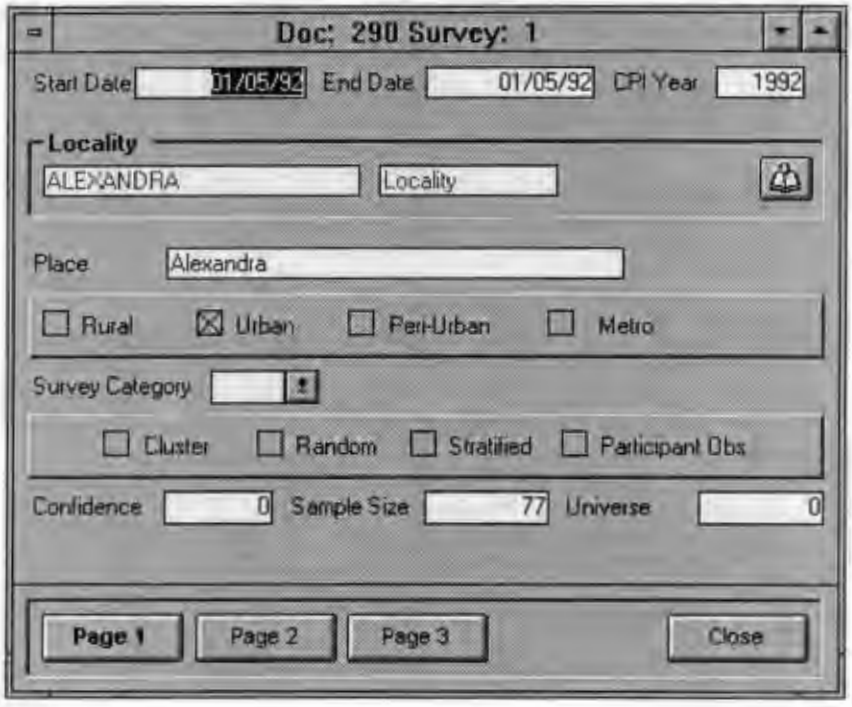


Figure 3.6: First screen of survey review information

The purpose of this is to link every survey in the system to identifiable geographic location so that aggregated data from the system could be displayed in a GIS output. Some survey places can be so small that they may not constitute enumerated areas, rather they are just portions of enumerated areas. For example, a survey place could be a zone in a big township or a small township or a small rural community. The database system aggregates data from such small survey places to the enumerated areas in which they occur. In such a case the *Locality* field will be the enumerated area whilst the name of the actual small survey place will be captured into the survey *Place* field.

Figure 3.7: Pre-defined locality builder

During data capturing or editing, the survey *placename* is typed into the survey *Place* field but the associated *Locality* field would have to be selected from pre-defined values in the locality builder as shown in Figure 3.7. The locality builder pops up

when the locality builder icon  in Figure 3.6 is double-clicked. As illustrated in Figure 3.7, Alexandra township was selected from the drop-down list in the *Locality* field in this figure. Consequently, Randburg Magisterial District and PWV (now Gauteng) Province where Alexandria falls are then automatically selected. The locality builder further selects a unique *Locality Code,* 7902603, which identify Alexandra on a GIS. Depending on the data available and the survey place in question, the locality code can be provided at any of the four levels of resolutions, namely: *Locality, Magisterial District, Provincial* and *National* levels.

On the second screen of the survey information review, items like settlement type and size are indicated if the survey report covered those issues. Figure 3.8 shows the information captured on this screen. Other issues covered on this screen are household definition and size, dwelling type and the extent of electrification.

There is a third screen that captures any extra survey review information that does not fit anywhere else.

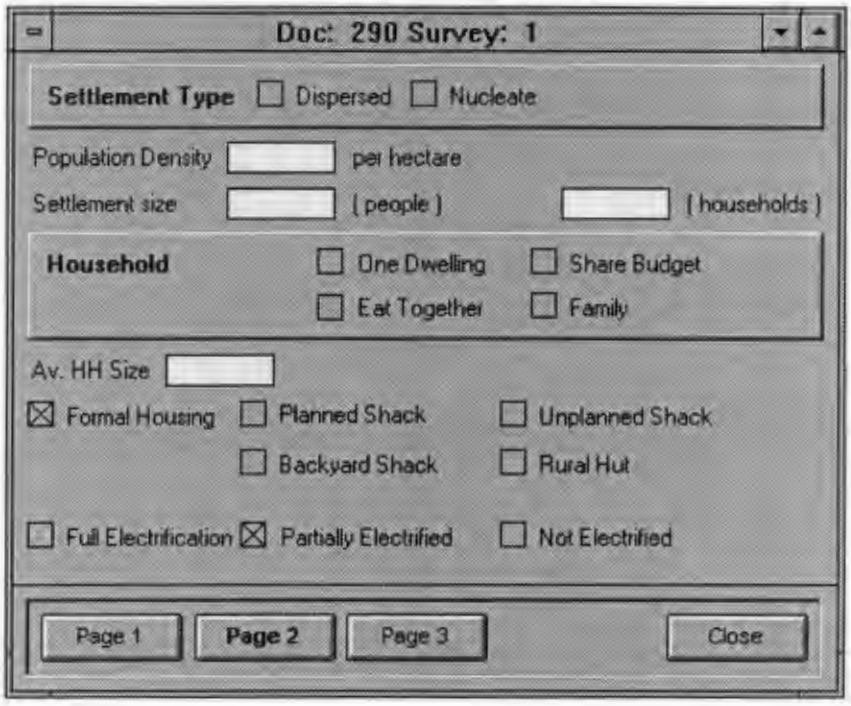


Figure 3.8: The second screen of the survey review information

3.2.4 Quantitative energy use data storage

As already mentioned, quantitative energy use data attached to the surveys of the secondary data set have been grouped into distinct categories. A screen displaying this list of categories comes up when the *Data* button on Figure 3.3 is clicked. Besides this list of quantitative data categories, one can also indicate on this same screen other general quantitative *Aggregate Data* covered in that particular report. In Figure 3.9, none of the select boxes on the left of this list of general aggregate data has been checked, which means that none of them is covered in report Number 290 or otherwise none has been captured into the database. In this figure, *Fuel Prices* has been selected as the category of data desired. When this category of data is double-clicked a table pops up, as shown in Figure 3.10, listing the fuel prices for all the

placenames of the surveys attached to document/report Number 290. The unit of each particular field can be seen in the status bar when the cursor is placed on a particular field. For example, the unit of the price of wood, cents/kg can be seen in the status bar when the cursor is placed in the *wood* field.

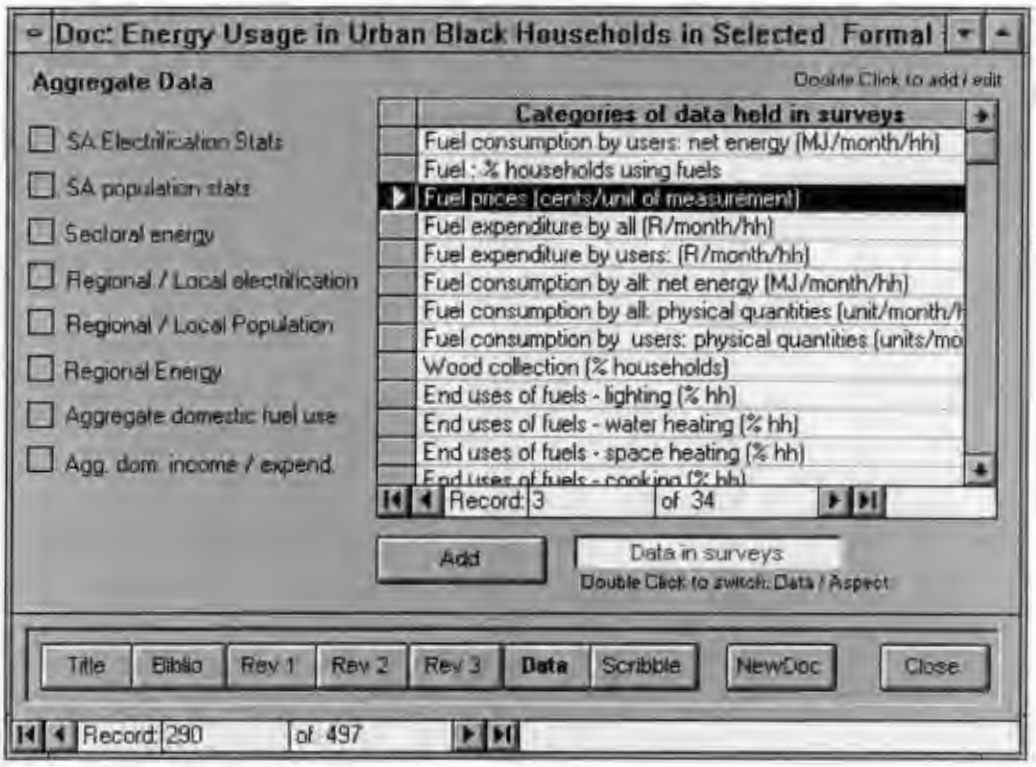


Figure 3.9: Selecting category of quantitative energy use data

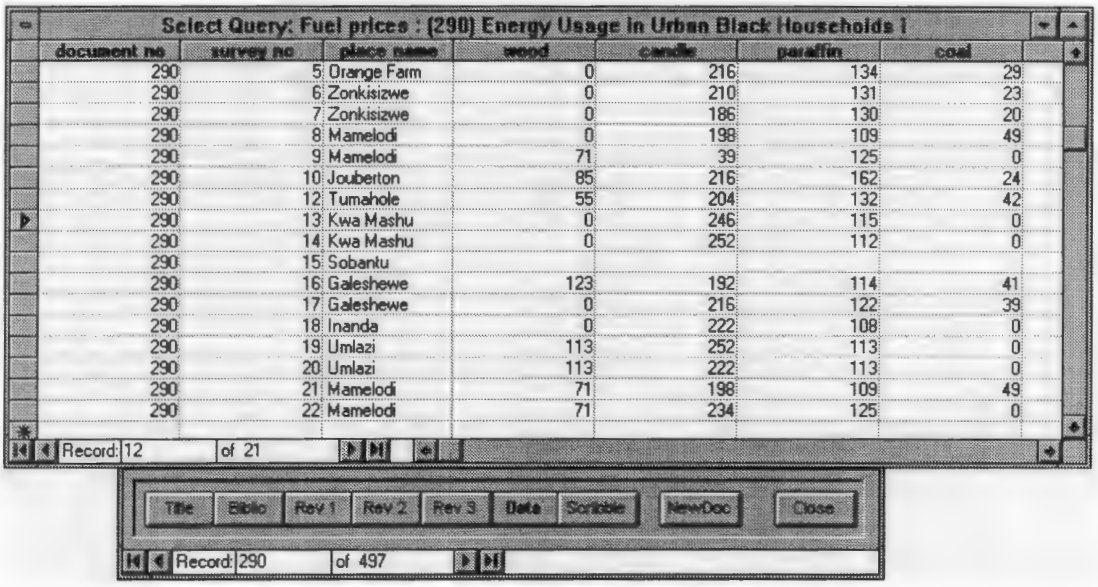


Figure 3.10: Quantitative energy use survey data linked to documents in tables

3.2.5 On-line help

There is an on-line help facility provided in the system. Wherever one is in the system, the help system is invoked when F1 is pressed. Like most Windows-based on-line help facility, help topics are linked to facilitate understanding of related issues. However, this facility does not provide deeper understanding of the system and would require further development.

3.2.6 Database documentation

In addition to the on-line help facility, a simple database documentation, which is an addendum to this report (Addendum 1) has been put together for the system. This manual provides a basic description of the internal structure of the database system. Part I of the documentation covers simple use of the database system and the application of query mechanisms called wizards for aggregating data on different levels of resolutions. Part II covers the more complicated aspects of the database design, for which an understanding of Microsoft Access is required. Part II also discusses the coding used for the various data stored in the tables, and explains how queries can be customised for more sophisticated requirements. The manual tries to explain how the database system has been designed to allow users to access the data easily and quickly with minimum understanding of the technical aspects of computer programming or database manipulation.

Apart from this separate manual on the documentation of the database, a table has been provided in the system itself called *DB_Structure* that lists all the important objects forming the database structure. Appendix A lists the names of the objects, the type of objects (table, query, report, etc.), their descriptions and where they are located in the system.

3.3 Data aggregation from the database system

3.3.1 Data aggregation from the secondary data component of the database system

As mentioned in Section 3.1.2, the NDEUD system is that which manages all the secondary data extracted from the various documents/reports on energy studies all over South Africa. In essence, it is the ENGDATA.MDB data file managed by the programme file NDEUD.MDB. Data aggregation from this system has been made possible through the design of a *Data Wizard* that serves as a primary query mechanism for the database. The Data Wizard is a short programme that leads the user step-by-step through the data selection process for building up queries from the database system. The wizard can organise the output of the data aggregation in four formats, namely:

- *Query output*: a spreadsheet-like output with the raw aggregated data not properly formatted. This format is useful when the output is required for further analysis in spreadsheet packages. Thus, this output can be exported to other packages for the required analysis or graphical presentation.
- *Report output*: a well-organised output with aggregated data properly formatted. This output is a preview of a printing output and it can be included in a report when printed out.
- *GIS output*: a Point Attribute Table (PAT) file including the aggregated data from the system. In this output the wizard creates extra data fields in a Geographic

Information System (GIS) PAT file for the exportation of the aggregated data into a GIS format. With the help of GIS software package like Arcview, the PAT file can be used to create graphical displays of the aggregated data in several map forms according to geographic locations.

- *SQL output*: a Structured Query Language (SQL) output of the query for more technical query design purposes.

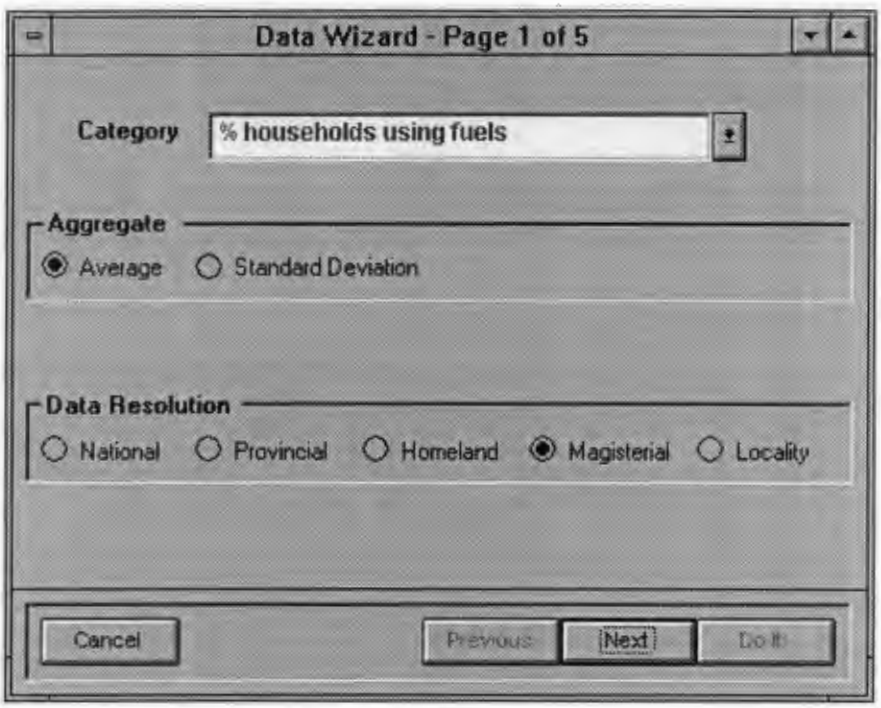


Figure 3.11: First screen of the Data Wizard

Access to the Data Wizard is gained through the clicking of the *Data Wizard* button in Figure 3.2. This brings up the first screen of the wizard that involves the selection of the data Category and the locality Data Resolution desired as shown in Figure 3.11. The level of data resolution to be selected can be National, Provincial, Magisterial District, former Homeland, or Locality. The lowest level of data resolution, which is the Locality level, is made up of the enumerated areas of the Central Statistical Service (CSS).

On the second screen of the *Data Wizard*, a list of data fields is made available for inclusion in the query depending on the particular data category that is already selected. As shown in Figure 3.12, higher data resolutions are made available for possible inclusion in the query should one be interested in sub-grouping aggregated data. Even though Magisterial District was selected as the data resolution in Figure 3.11, the Provincial level has been made available for possible inclusion in the query in Figure 3.12 so that the energy usage patterns for the Magisterial Districts could be grouped into their various Provinces, if so desired. The clicking of the *Zoom* button in Figure 3.12 also allows the user to edit the field names of the data as desired. This is especially useful for distinguishing data in the NDEUD system from the Saldru System. If data from the two systems are combined in the query it is necessary to give clear indications of this in the field names.

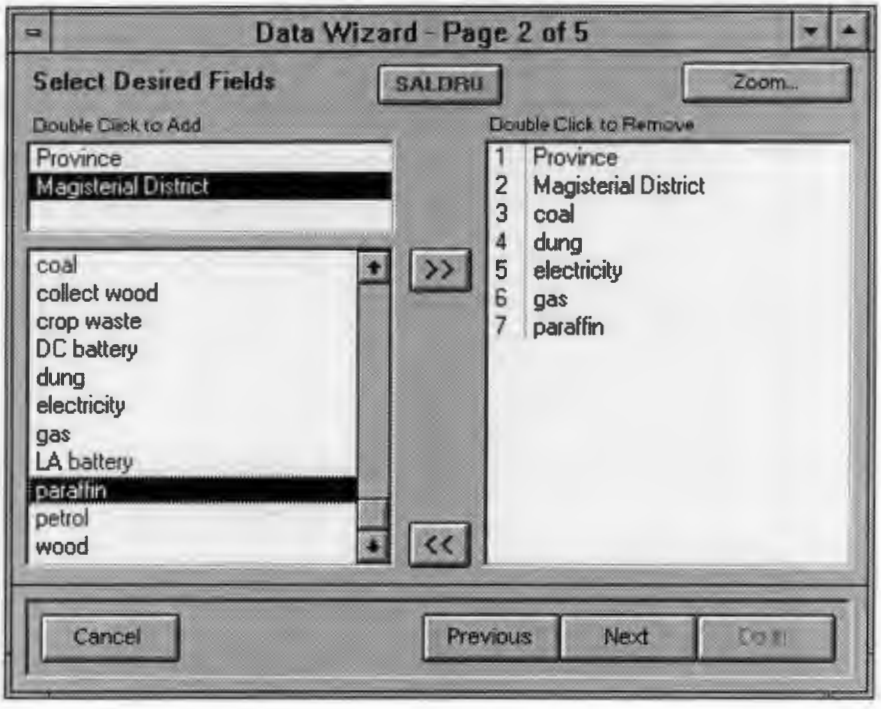


Figure 3.12: Data fields selection screen of the Data Wizard

The next screen of the Wizard lists 20 restrictions that can be specified on the data aggregation as shown in Figure 3.13. Most of the restrictions are simple logical (yes/no) fields but there are some that require specific name, number or code to be stated. For example, to restrict the data aggregation to some specific magisterial district, the user will have to use the Locality Builder icon for the selection of the specific codes interested in as explained in Section 3.2.3. The codes identified in the builder can then be copied to the Magisterial District Restriction field in Figure 3.13 using the usual Windows CTRL-C keyboard combination. For the query in Figure 3.12 only two restrictions have been specified and these are that the query should only select data on *Urban, Planned Shacks* as shown in the figure with Yes in those fields. Also, as indicated in Figure 3.12, double clicking of a field on the left side of the figure selects that field onto the right side for inclusion in the query.

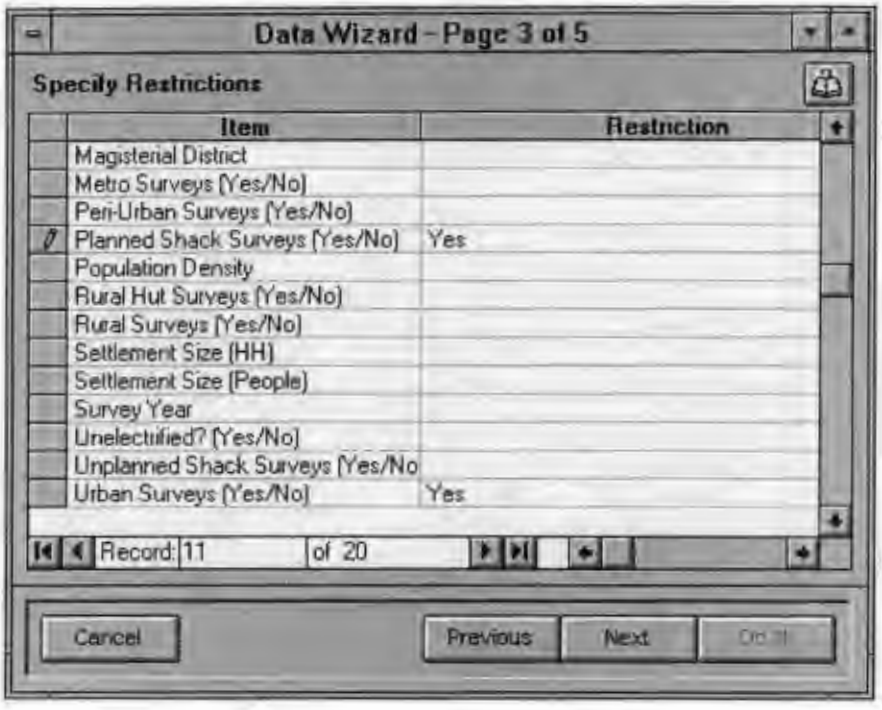


Figure 3.13: Specification of restrictions on data aggregation

Figure 3.14: Output options for the Data Wizard

The fourth screen of the Data Wizard provides three options for the format of data aggregation output desired as shown in Figure 3.14. Report, query or GIS outputs are the options available. For the report and the query outputs, a portrait or landscape page set-up can be specified. In addition, an appropriate title describing the report or query may be specified; otherwise the system will provide a temporary name for it. If the output would be required for future reference it can be saved in the *InfoWizard* with an appropriate title. For

cost-related data, like fuel expenditure, the required year for the consumer price index (CPI) conversion would have to be specified as shown in Figure 3.14. In this figure, all cost-related data will be converted to 1995 values using CPI for the conversion. The clicking of the *GIS* button runs the query as well as initiating the exportation of the data into a GIS PAT file. The PAT file is then accessed through Arcview for the creation of views. The query can be executed on the fourth or the fifth screen. The last screen of the Data Wizard offers the option to provide the SQL of the query for further technical design.

3.3.2 Data aggregation from the primary data component of the database system.

The Saldru system is that which manages the energy use and related data extracted from the Saldru/World Bank national survey in 1993 (SALDRU 1994). It functions in the database system as the SALDRU.MDB data file managed by the programme file NDEUD.MDB. Data aggregation from the Saldru system is provided through the application of a *Saldru Wizard*. The Saldru Wizard works on similar principles as the Data Wizard with few modifications. Unlike the NDEUD system, the Saldru system does not require a selection of data category for the Saldru wizard. The Saldru wizard uses the same first screen of the Data Wizard for the selection of its locality data resolution as was shown in Figure 3.11. On this screen, no data category is required for selection. Data resolution is permitted only up to the Magisterial District level since the raw data is not further disaggregated.

After the selection of the data resolution, the Saldru Wizard is initiated by the clicking of the *Saldru* button on the second screen of the Data Wizard (Figure 3.12). At this point the Data Wizard branches off to the Saldru Wizard. The first page of the Saldru Wizard lists all the data fields available in the Saldru system on the left-hand side of the screen. The main difference here is that all the data fields in the Saldru system are listed whilst in the case of the Data Wizard only the data fields of the chosen category are listed. The list of fields is more lengthy but it has been ordered alphabetically to make it easy for making selections. The typing of the first few letters of the field brings up the focus on that particular field for selection. Double clicking on that field selects it onto the right hand side of the screen. There is also a *Zoom* button on this screen with the same function as the one in the Data Wizard (Figure 3.12).

The second page of the Saldru wizard is similar to the third screen of the Data Wizard, the only difference being that more restrictions are available for specification in this case. In the third page of the Saldru Wizard a query or a GIS Link or an SQL output can be specified. However, for a report output, the Saldru Wizard must be closed for a default return to the Data Wizard. The Data Wizard is then proceeded to its fourth page where the option for a report output can be selected. At this point the output can also be saved with the *InfoWizard* by providing an appropriate title.

Depending on the computer hardware being used the Saldru system may run very slowly since it has very large number of records to go through in each query. The GIS transfer of the data may take much longer in this case than the case of the NDEUD system.

It is possible to combine data from both systems as separate data fields but this would have to be indicated clearly by using the Zoom button. To combine data from both the NDEUD and Saldru systems the desired data fields in the NDEUD system are selected first in the second page of the Data Wizard. Then the Saldru Wizard is clicked for the selection of additional fields from the Saldru system.

3.3.3 Sample outputs from the database system

GIS outputs display the aggregated data in the form of provincial and magisterial district maps of South Africa. The shades of the provinces or magisterial districts depict the quantitative information aggregated. An example of this has been depicted in Appendix B showing the monthly household expenditure on electricity in the sampled magisterial districts of the Saldru study. It must be noted that the Saldru system gives a better coverage of the country than the NDEUD system since the former was a national survey whilst the latter was mostly local surveys put together. It is hoped that as more data is entered into the NDEUD system the coverage could be improved. The printouts of the GIS outputs from an average printer do not have good resolution compared with the usual clear displays on the screen. For better printouts of the outputs high quality printers are required.

Appendix C shows some of the report outputs from the energy use data aggregation of the database system. Most of the outputs in this appendix were done as a response to a request by someone in Eskom for their electrification programme in Kimberly, the Northern Cape Province. A report output can be information on magisterial districts alone or provinces alone or magisterial districts grouped into their various provinces.

One output of the NDEUD system can also be an overview of the content of the database. Appendix D shows a shorter version of a report on the list of documents/reports in the database. This list shows the title of the study, the author, the publisher, the publishing date, etc. Similar separate reports are possible for rural and urban studies.

4.
Database enrichment

The focus of this task in this phase of the project was more on the improvement of the quality of data in the database rather than in the quantity of data. Even though some documents had been entered into the database, not all important survey data in the documents had been captured. This was usually due to clarifications required concerning the way certain data had been presented in reports. A lot of effort was spent on capturing useful data originally left out in some documents that had already been entered into the database, thus filling in the necessary gaps.

The conversion of the database from one software version to another also created zero data values in certain data fields where data was non-existent. Such errors resulted in distorted picture in the output of analysed data. Therefore some effort was also spent on the cleaning up of such errors in the database.

One of the important documents that were added to the database is the Eskom's South Africa A-Z which has valuable analysed data from the Eskom Omni Panel Survey in 1995. Unfortunately, efforts made to secure the data in electronic format in order to speed up the process did not materialise. Consequently, the data had to be laboriously captured in a manual way from the report. Due to the extensive nature of the data, only a small portion of the data capturing has been completed.

The data capturing activity was used as a capacity building opportunity for some staff at EDRC. For example, a researcher working on the DME project on *Social Determinants of Energy Use in the Western Cape* (Mehlwana & Qase 1998) was co-opted into this project to assist in the data capturing activity. In this way the researcher gained experience concerning how data is captured from research reports and also how the captured data could be organised in a database to provide information for policy making. The project also gained from the field experience of the researcher by ensuring that data captured into the database had gone through the necessary critique. This symbiotic arrangement helped the project to cope with the financial constraints concerning the data capturing activity. However, this arrangement could not be sustained for long.

The sections below describe the processes, theories and methodologies that have enhanced the capturing of data into the system including the constraints encountered in the processes. The actual data capturing procedure is not discussed in this chapter since it has been extensively described in Chapter 3.

4.1 Database development in the IEP process

Bouille (1992) cites database development as an essential prerequisite to the implementation of an integrated energy planning (IEP) process. It involves the data aspect of energy planning. If energy planning can be considered to be a set of activities leading to the structuring of information so as to facilitate decision-making, database development would reach over the entire gamut of energy planning (APDC 1985). The ultimate goal of data base development is a complete, reliable and disaggregated energy and socio-economic information as a resource for IEP.

Database development has to be understood as very much a part of the iterative process of IEP. Although the database serves as an input to demand and supply analysis its development does not precede the analysis stage. Usually database development and analysis are carried out simultaneously, with considerable iteration between them. As the planning process becomes more sophisticated, the quality of the database, as well as that of the energy plans constructed, will improve. Even if the initial data set is incomplete and simple, it allows for a consistent and comprehensive approach to analysing national energy problems which is superior to the traditional uncoordinated planning by sub-sector (Eberhard 1992). In this way data gaps can be clearly identified and further research could incorporate the necessary data collection. A case in point is the development of energy demand data in the Energy Policy Research and Training (EPRET) project at the University of Cape Town in 1992-93. At the beginning of the project a coherent set of data describing low-income household energy usage was not available. The development of energy demand data therefore had to start from scratch at the same time as other policy work (Trollip 1994:4). In the words of the research outline:

> The analysis of existing primary and secondary data sources (of energy demand data) would *provide the starting point* for the sectoral studies dealing with energy supply options in both urban and rural areas. In turn, the energy usage information would be refined by closer investigation undertaken in these sectors (Eberhard 1993).

The most distinguishing characteristic of database development is that it provides a quantitative framework for energy planning. The amount of data required for energy planning can be enormous but it should be borne in mind that the importance of database development does not lie in its sophistication, but in the extent to which it is useful for energy planning. It must endeavour to provide answers to analytical questions concerning energy needs, and the means and resources for achieving those needs.

In IEP, it is not sufficient for an energy database to provide answers to analytical questions like "how much energy from a specific source is required by a group of people or households or a sector of the economy for a period of time?". Database development requires questions more pertinent than this in order for the IEP process to be *demand oriented* and *end-use driven*. Rather, the database must go on further to provide data on the specific purposes for which energy is required, and also, the technology or devices or appliances with which those purposes can be achieved satisfactorily. In addition, it must be able to appraise how accessible and affordable the supply of energy from specific sources and their respective technologies are. The database must also disaggregate consumers into smaller groups with likely energy use patterns so that energy supply solutions can be properly channelled.

From the onset, then, data is required for energy demand analysis and energy supply analysis. APDC (1985: 28-34) specifies three main sequential steps in database development, namely, *identification of data required*, *collection of data identified* and *assembling of data collected*.

4.1.1 Identification of data required

This step in database development relates to a country's energy system where activities of production, transformation and consumption of energy interact. It also pertains to variables and parameters that influence the energy system. According to the IEP Manual by APDC (1985) there is no ready made or standardised database since, as a planning concept, IEP does not prescribe any universally applicable data

requirement. The kinds of data and the level of their detail required for a database depend solely on a country's energy situation and its policy objectives.

For the purposes of *energy demand analysis*, data requirement can be grouped into two categories. The first category comprises information affecting the demand for energy. This includes information on macro and sectoral economic activities, prices, demographics, climatic conditions and governmental policies and regulations. It explains the close relationship between energy consumption and socio-economic activities. The second aspect of data is on energy demand proper. This consists of data on actual energy consumption by economic sub-sectors (e.g. households) by demand categories (or end-uses like space heating and lighting) by energy source (e.g. electricity, fuelwood, and coal). Data on conversion efficiencies of end-use devices is also important at this stage.

For energy supply analysis, data is required on energy resource assessment (including total reserves and possible production rates) and technology evaluation (involving all types of technologies for transforming raw energy materials into energy forms useful to the consumer.

4.1.2 Data collection

Data collection for energy demand analysis usually involves the design of time-consuming and expensive surveys and questionnaires. It is therefore necessary to review existing data sources before beginning the actual data collection exercise. In some cases much of the required data can be generated from *secondary sources* (i.e. existing statistics, published and unpublished reports, macro and sectoral plans and programmes). However, in many cases, *primary data* is required, and this is where the design of questionnaires and surveys are very important. Primary data is usually difficult to collect and, therefore, a carefully designed method is required. This includes data on end-use energy consumption by households by fuel source and demand category such as cooking and space heating.

Often surveys are the only means to gather primary information for energy planning. There are no generalised survey methods or approaches that are universally applicable. The survey design will differ according to a country's energy resource situation and according its energy consuming sector or groupings. Practically, there is a limit to the resources available for surveys (time, skilled manpower, and money). Therefore proper sampling is important in order to utilise the available resources efficiently to achieve a desirable coverage in the survey.

Special attention is required for collecting data on traditional sources of energy that supply a substantial portion of the total energy demand of low-income households. Traditional energy sources data are difficult to collect and assemble due to the complexities involved in estimating their consumption. Care should therefore be taken when integrating such data with formal energy systems.

4.1.3 Assembling data collected

The last step in database development is the assembling of the data collected in a comprehensive and consistent manner for integrated analysis and decision–making. Again, there is no single database framework that is superior to others, the country situation would determine the appropriated level of detail and framework suitable. Most of the rest of this chapter deals with how both primary and secondary data on

energy use in low-income households have been assembled in the *National Domestic Energy Use Database System*.

4.2 Review of secondary data sources for the database development

As discussed above, the development of the domestic energy use database had to largely involve the collation of data from diverse kinds of studies. The extraction of data from these secondary sources required critical evaluation, since the data in the various studies were not generated primarily for energy planning and, as such, varied in terms of measurement factors, time periods, methodology, and so on. None of these studies had a national coverage; rather they covered certain selected rural, peri-urban and urban areas in different parts of South Africa.

Rural energy studies in South Africa have been extensively reviewed by Ward (1995) detailing the types of existing studies and their shortcomings, quality of data, and coverage in terms of geographic location and issues of energy use and related variables. Loon (1996: 61-69) also reviews a selected representation of rural energy studies in South Africa in terms of their methodological approach with respect to IEP. This section does not attempt to review in detail the sources of the secondary data in the database since this has been extensively done in the review and bibliographic component of the database itself (see Sections 3.2.2 and 3.2.3). However, an attempt has been made to summarise briefly below the types of studies from which data were extracted into the database, and also, a general observation of the studies, especially the constraints in capturing data from all the different sources of data into one database.

4.2.1 Types of studies

At the outset, a comprehensive search for all energy and energy-related studies on households in South Africa was initiated. This happened in a period when most institutions were struggling with the transformation of South Africa into a society of openness. In spite of the initial difficulties, the search produced overwhelming results, bringing together hard copies of reports and papers on diverse kinds of studies. Each of the reports was carefully read and the data therein critically examined.

All the studies were classified by the type of information that the particular studies purposed to gather. Another categorisation of the studies was by the kind of institution that commissioned or conducted the studies. Some of the types of studies are:

1. Energy survey/studies
2. Policy/analysis
3. Income and expenditure survey
4. socio-economic surveys
5. In-depth studies
6. Conference papers & journal papers
7. Thesis (MSc. & PhD)
8. Development studies

4.2.2 General observations of studies: constraints in data capturing

There were many constraints to the capturing of data from the various studies. Many of these constraints are resource-related. The reading of the reports requires the services of specialised personnel with qualified experience and knowledge about household energy use especially in the low-income areas. This ensures that accurate data is captured to offer the database a good foundation. This aspect is also time consuming since the data captured from one report would often require some manipulation in order to fit into a common form for the data from all other studies. The design aspects of the database have also been a daunting task as well as the database maintenance. It must be obvious that a lot of thinking needs to go into the task of designing of a common database to suit data that has already been gathered under different circumstances, by different researchers with different objectives and methodologies.

There are other constraints too that are related to the studies themselves. Some of these constraints are:

- **Geographic coverage**. While some areas have been extensively researched, and sometimes research has been mere duplications, other areas have very scanty coverage. Although the database is useful in this regard in exposing research gaps, it does also render the aggregation of data on regional basis less meaningful. Coverage in rural areas is worse than in urban areas with some rural areas being completely neglected. Areas in the former homelands are also poorly researched. For example, the only useful study on Venda that could be identified is one undertaken as far back as 1989 on the demand and supply of firewood in the homelands (Aron, Eberhard and Gandar 1989). Although there are some few useful studies on the former self-governing states like Gazankulu and KwaZulu, others have scanty information. Qwa Qwa, Lebowa, KwaNdebele and KaNgwane have poor coverage of data on household energy use.
- **Units of measurement**. In some studies researchers ignore the importance of the units of measurement in their presentation of data. This is probably due to the fact such a study report was intended for the internal readership of an institution and, as such, units were usually known to be of a specific format. However, this creates problems when such data is integrated with data from other sources.
- **Study review problems.** In some of the studies no background information was reported on the study and in some others no objectives were provided for the study. An example of this problem is the frequent omission of the *sample size* and the *universe* for the sampling in the reports of some studies. With no information on the sample size and the universe it is impossible to estimate how representative the available data is. This creates review problems since accurate data can only be extracted when it is placed in the appropriate context.
- **Poor identification of study locality.** Some studies completely leave out a description of the physical location of the study area. Others that provide this do not include the necessary information like maps to clearly mark out the study area and the way it is linked with other geographic locations within South Africa. In some instances the names of certain localities and settlements have been spelt or given names differently in various reports. There are a few reports too where localities have been wrongly placed. A lot of effort has been put into this project reconciling these differences and omissions in order to provide unique locality for

each study. This is necessary for the purposes of data aggregation at different levels of locality so that no data is lost in the process.

- **Loss of survey data.** Usually, only a few tables of data are included in a report. The data that is presented therefore provides only a small fraction of the utility that the underlying data from the survey work actually holds.
- **Omission of references.** There have been times when one requires information from the author of a report (or his/her institution) in order to make any sense out of the data in the report. In some cases explanation or clarification of a methodology or measurement or a study location or objective is required, and in other cases more empirical data is needed. However, some reports leave out the institution of the author or the institution that commissioned the study. There are some instances where authors names cannot be identified. This makes it difficult to track the source of the data set and renders any data authentication process futile.
- **Limited grouping of data.** The data in reports are usually aggregated data that have been grouped into pre-defined categories. This limits the reader of such reports to the categories pre-defined in the report. To be able to re-group the data to suit the categories in the database one would sometimes require the actual data behind the pre-defined categorisation. For example, in the database, data is categorised according to *dwelling types* whose definition go beyond *informal* and *formal* households. Thus studies with data categorisation according to formal and informal categorisation pose a lot of problem in data capturing. Another example is the categorisation of data into *urban*, *peri-urban* and *rural area* in the database. For reports which categorise data into only rural and urban, one would require some background information in order manipulate the data into the preferred categories. It must be mentioned that a lot of care is needed in such data manipulation, and in many cases data manipulation is virtually impossible or meaningless.
- **Omission of research dates.** Since the policy environment is rapidly changing one must be conscious of the time certain findings are made. Furthermore, for proper demand analysis and projections, time is a crucial factor. One must be able to track the changes in energy use patterns with time. Unfortunately, many of the studies have not reported the time in which survey data were collected.
- **Lack of information on statistical usefulness.** To bunch together aggregate data from different sources without any information on the statistical usefulness of the data can be very misleading. While some reports do not provide information on the sampling method used in the study, others do not even mention the sample size for the study. Some of the reports with information on the sample size too omit the size of the universe out of which the sample was selected. In such situations it is difficult to assess representativity of the data presented in the report.
- **Conflicting definition of terms.** The most confusing constraint in the reports is the conflicting nature of definitions given to some of the terms in the reports. For example, energy consumption can mean a lot of things if the report refuses to define it adequately with the appropriate basis and units. Energy consumption can be in terms of physical units (e.g. weight of wood, volume of paraffin, etc.) or useful energy or delivered energy. The basis of measurement can be *all the households* in the study or only those *households using* the particular fuel.

Estimation of consumption must also state clearly whether it is weekly, monthly or annual consumption. These minor omissions sometimes make the data in reports worthless. Another example is the definition of "the household" which many studies take for granted. Since most of the household energy demand variables are measured in terms of the household unit, inappropriate definition of the household can easily distort the picture of energy use patterns. In like manner, the omission of a definition of the household in a report on a study also reduces the integrity of the data it presents.

- **Conflicting research methodologies.** The research methodologies of a lot of the studies are in some cases found to be diametrically opposite to the purpose of the database. While the database is designed as a tool for integrated energy planning, a lot of the existing data were collected with supply-oriented approaches. Clear examples are the Eskom S1 reports (Eskom 1991, Eskom n.d.a, Eskom n.d.b, Eskom n.d.c) which are basically electricity marketing studies aimed at finding out people's attitudes towards electricity and their affordability. The marketing bias in the studies is clearly seen in the questionnaire design and the data presentation. All the studies have almost the same format, based on the same questionnaire in spite of the different study areas, and usually the dates of the studies are not reported.

  A second example is found in the studies by Gandar (1988) and Rivett-Carnac (1990) where even though the idea of integrated energy planning was posited, a different interpretation was employed. The word "integrated" in IEP was interpreted to mean "holistic" in the sense that all energy supply options should be considered, with special emphasis on an ecologically sound exploitation.

  Loon (1996: 62) cites a review of a study by Eberhard & Dickson (1987) as another example. In this case, even though the IEP principle was followed in the sense that energy demand was analysed before considering energy supply scenarios, the energy sub-sectors were taken as the focus for the analysis, causing overlapping of end-uses and subsequent inadequate analysis of the energy services by the sub-sectors.

- **Lack of important cross-tabulation.** Many important cross-tabulations of the demand and supply variables are very important in assessing the effect of one on the other. However, such cross-tabulations were largely left out in many of the reports. For example, even though there were substantial amount of data presented on income and demographics, these variables were not, in many cases, cross-tabulated with energy use variables like energy expenditure and consumption. Thus the relationships between these variables are not easily analysed.

- **Omission of important data categorisation.** The restrictive nature of data categorisation in the studies has led to the insufficient coverage of important social issues like gender and power relations concerning energy use in the household. Only a few studies, like that of Annecke (1992), deal with gender issues.

- **Lack of data on important energy demand variables.** A lot of the studies left out important energy demand variables. End-use information was generally lacking in most of the studies. Data on appliance acquisition is also very poor in most of the studies. Moreover, data that was not disaggregated into dwelling types could not easily fit into the design of the database.

4.3 Domestic energy consumption variables

From the onset, energy planners should be cautioned about the use of the term "demand". The notion of demand typically expresses a relationship between price and quantity in a free market system. It represents the quantities that will be purchased at a given price. On the other hand, when the purchase has been made, like in most energy usage situations, we refer to "consumption" rather than demand. But actual consumption may obscure unfulfilled demand, particularly in South Africa where demand was intentionally suppressed by restricted access of black households to energy services. In compilation of historical data the equivalence of demand and consumption is often assumed.

Energy consumption and the choice of fuels consumed depend on interrelated variables. It should be obvious that many of these variables overlap and that there is often no clear distinction between variables that affect demand and supply. For example, the cost of end-use equipment is listed below as a demand variable since it concerns the final end of the energy supply-conversion chain and is linked to factors such as income, preferences for using certain fuels, and even tastes in the case of cooking equipment. However, end-use technologies are often fuel-specific, as with a kerosene lamp or stove, and so depend on supply-side issues such as the availability and price of fuels, and the price of the household equipment.

Some of these interrelated variables have been listed by Leach and Gowen (1987: 33-35) as listed in the section below:

4.3.1 Supply variables:

1. Price (for marketed fuels).
2. Abundance and scarcity of fuels. The measurements of these variables are not easily defined. They include the "time" and "effort" devoted to fuel gathering and fuel use; access to fuels by different household types, seasonal variation in supply.
3. Fuel preferences. The reasons for choosing particular fuels and their associated appliances are usually determined by the characteristics of the energy output of the fuel. For example, in cooking, some fuels will be preferred to others because of the handling and lighting, flame quality and temperature, ability to secure fire from children, smokiness and the taste imparted to food. In a study by Cline-Cole (1981) in Sierra Leone, the cost of woodfuels relative to that of fossil fuels was the least important consideration for fuel switching by households. Although the average family in the town of Waterloo, Sierra Leone, spent 30% of its income on firewood, two-thirds of them would not switch from it because of reasons including food tastes, safety and wider range of cooking methods that are possible with open fire. Fuel preferences are also influenced by cultural and socio-economic factors such as gender differences over decision-making.
4. Urban, peri-urban or rural location (i.e. settlement size and proximity to large towns or cities). These factors are closely related to supply factors such as fuel availability.
5. Substitutes for fuel and non-fuel uses of biomass (e.g. the availability of dung and the competition between the use of dung as a manure in agriculture and as fuel for cooking and heating in rural poor households).

4.3.2 Demand variables:

1. Household income.
2. Household size.
3. Climatic factors like temperature, relative humidity and rainfall (for space heating and drying needs).
4. Cultural factors (diet, cooking and lighting habits, etc.).
5. Cost and performance of end-use equipment.

5.
Database expansion

5.1 Linkage of database system with primary data set

In the first phase of the project no primary data set was linked with the secondary data set in such a way that data from it could be analysed in the user-interface. During this second phase of the project the system was expanded to include a primary data set from the World Bank/SALDRU study on poverty statistics and standard of living (World Bank 1994) as has been mentioned in Chapter 3. This data set comprises almost 9000 household records in about 180 magisterial districts covering all provinces in South Africa. Only the data fields relevant to domestic energy use were extracted into the system.

The system design had to be completely changed to accommodate the large volume of records in the SALDRU data set. Since this new large data set had a different structure and the data itself were in coded form, a lot of computer programming was required. Besides, the data set had to be cleaned and reformatted to facilitate linkage with the main database. Chapter 3 describes in detail the structure of the linkage of this primary data set with the secondary data set.

GIS Linkage

In addition, the system was expanded to include a facility that creates a Point Attribute Table (a PAT file) for displaying analysed data in Geographic Information System (GIS) package like ArcView. This is not a live-link of the database to the GIS but a temporary GIS PAT file that gets created any time analysed data is exported into a GIS output. These temporary PAT files have been used to create permanent shapefiles that are further used to create ArcView displays at provincial level and magisterial district level. Chapter 3 gives a detailed description of the GIS linkage and a sample GIS output has been included in this report as Appendix B.

Other user-interface expansion

As has been described extensively in Chapter 3, the user-interface was improved immensely to make it user-friendlier. A sophisticated query mechanism was incorporated in the user-interface and a reporting system was designed for the outputs of the queries. A simple help system was also incorporated in to the database.

Query mechanisms for the NDEUD web site.

The database system was expanded to include the design of an on-line database query mechanism for the NDEUD web site development mentioned in Chapter 2. Both primary and secondary data sets have now been decoded and can be queried through a query mechanism that runs in Microsoft Access at the background of the web site.

The concept of the design of the query mechanism for the NDEUD web site was based on the following advantages:

- The data is available to all in the country with Internet access and around the world, instantly, without distribution or maintenance costs to the user.
- Those without access to the Internet or computer can be supplied with printed outputs from the on-line queries.
- The data is centralised, so updates need occur only in one place. New data is immediately available world-wide.
- The software is centralised, so bug-fixes and the addition of new functionality need occur in one place only. Users immediately enjoy the new features world-wide.
- Users need not invest in a database product, or a GIS product, to use the full features of the system. They only require an Internet browser – these are freely available to many institutions and organisations these days.
- Users do not require powerful computers to process complex queries. All computation is done on the server, and users can access the system with their existing hardware.
- The system is available cross-platform: users can access the database from Windows-based machines, from Macintosh machines, from Unix machines, and any other computers that can access the Internet.
- The system remains current: as new operating systems and software are introduced, the Internet communication systems fairly remain a standard, so users will not be forced to remain with old software or hardware to access the database.

The NDEUD web site development has been approached in a three-phase design process.

Phase one: Site development and on-line database query

Phase One of the development included the graphic design and feel of the site, and the ability to query the database. This query includes a selection of the required data categories and fields, and the ability to specify restrictions on the data the user is interested in. The web site can be surfed at the following address:

http://yaw-afrane.erl.uct.ac.za/

This site should be viewed with Netscape Navigator 3.0, or Microsoft Internet Explorer 3.0, 800 x 600 pixel graphics mode (or later versions). The site begins with a basic welcome page, and the user should select on-line, to view a brief example of an on-line database query system. Basic instructions concerning how to proceed with a query are also provided. The user can specify the category of data and fields required. For example, "Percentage of households using fuels" can be chosen as a category and the data fields that can be selected in this category are wood, paraffin, electricity, coal, etc. A set of restrictions can then be set against the data extraction if desired, for example, data for rural dwellings alone. An example of this on-line query selection is shown in Figure 5.1. In the query shown, the data is expected to be aggregated to the provincial level.

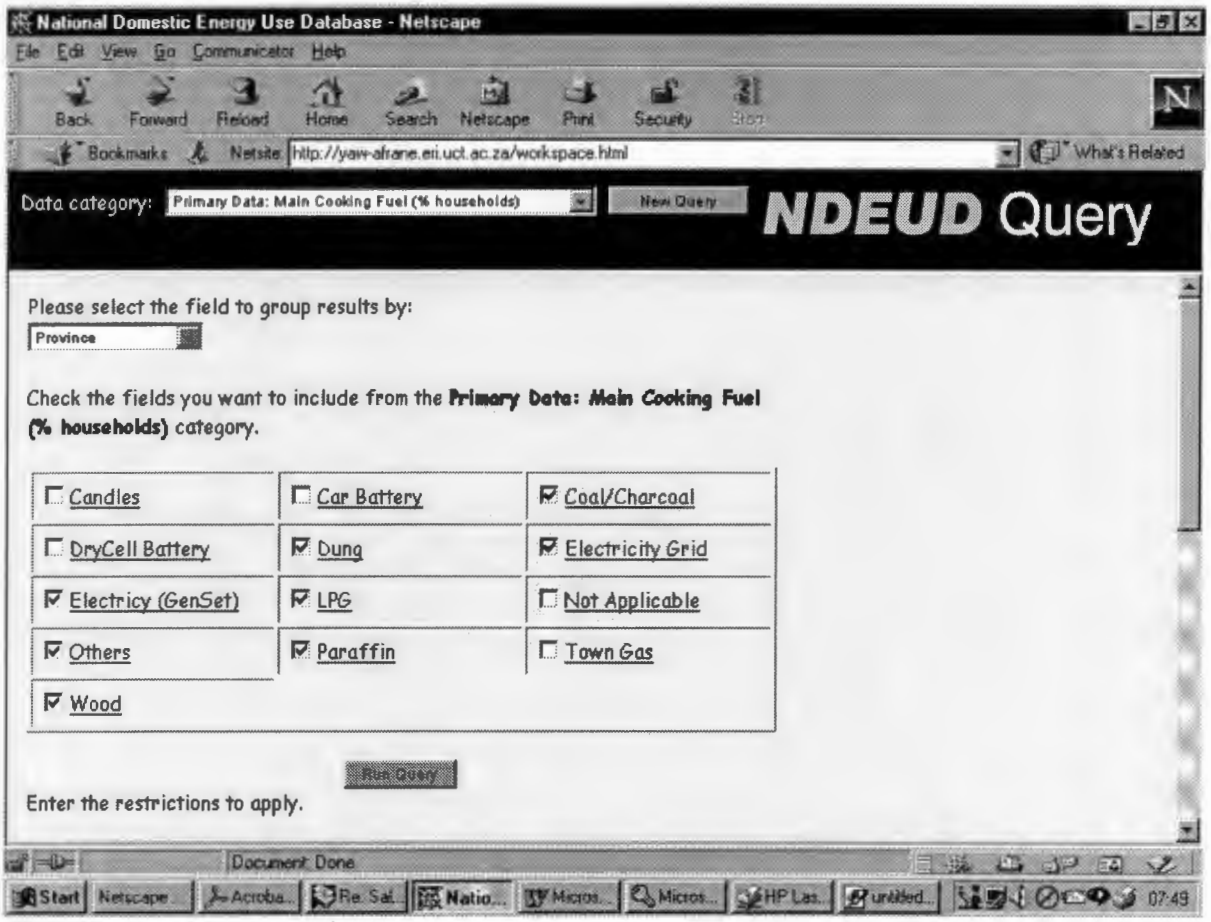
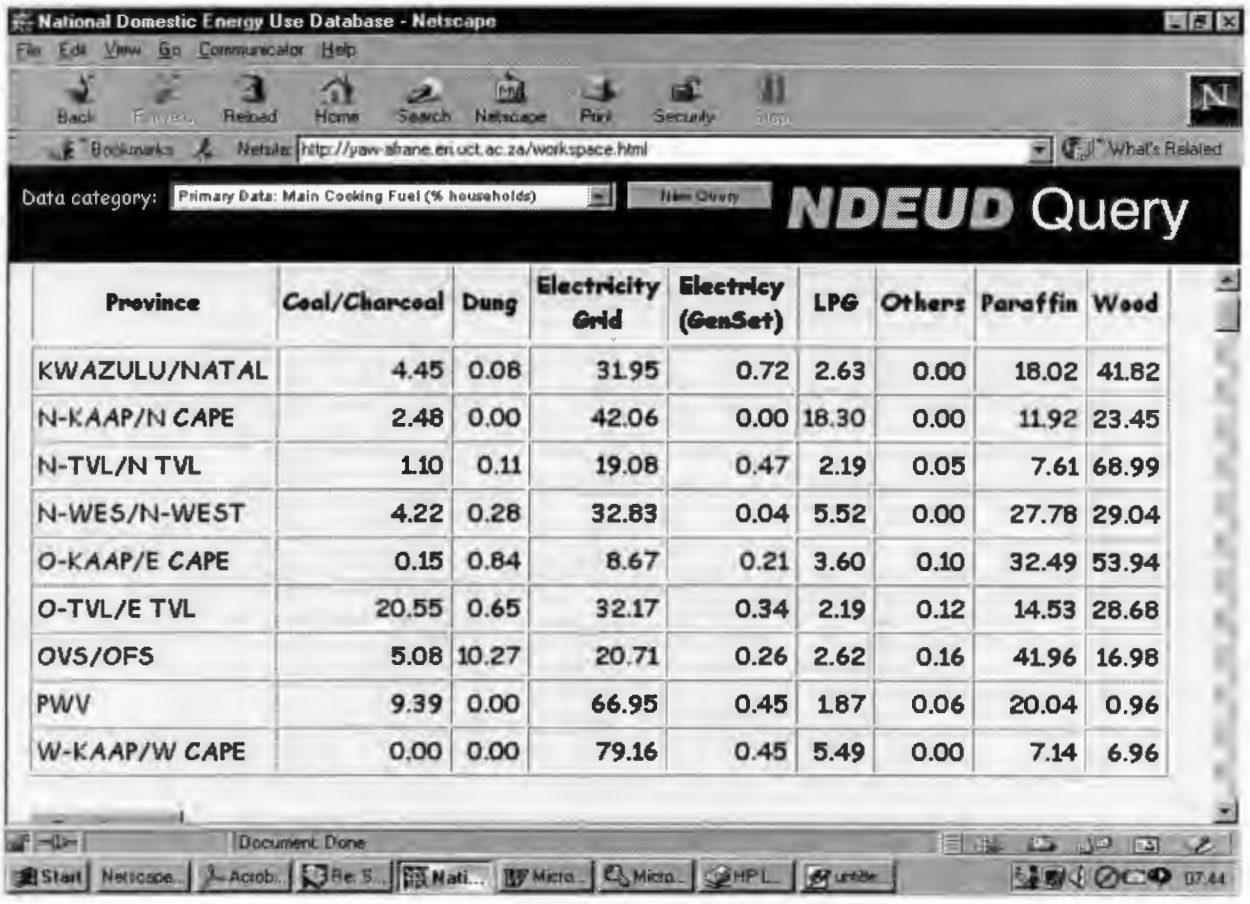


Figure 5.1: Query selection format

Once the user has specified these restrictions, the database performs the query and returns the results in a tabular format, or in a text file format. The latter format can be used for directly importing the data into a spreadsheet for graphical presentation or further analysis. The output of the above query is in the form of Figure 5.2. The clicking of the Text Output button results in a procedure for importing the data into a spreadsheet. It must be mentioned that when the page in Figure 5.2 is scrolled down a list appears which is the bibliographic information on all reports or studies in the database from which the data has been extracted for the query.

The first phase of the web site was completed with a free run Netscape FastTrack Server. The server runs off a 133MHz Pentium computer based at the Energy & Development Research Centre. This made it possible for the NDEUD staff to work directly with the database while on-line. For this purpose, web server software would have to be eventually obtained. This software does not represent a large expense. We would recommend Netscape's FastTrack Server, which retails at US$295, and is extremely easy to maintain.



Province	Coal/Charcoal	Dung	Electricity Grid	Electricy (GenSet)	LPG	Others	Paraffin	Wood
KWAZULU/NATAL	4.45	0.08	31.95	0.72	2.63	0.00	18.02	41.82
N-KAAP/N CAPE	2.48	0.00	42.06	0.00	18.30	0.00	11.92	23.45
N-TVL/N TVL	1.10	0.11	19.08	0.47	2.19	0.05	7.61	68.99
N-WES/N-WEST	4.22	0.28	32.83	0.04	5.52	0.00	27.78	29.04
O-KAAP/E CAPE	0.15	0.84	8.67	0.21	3.60	0.10	32.49	53.94
O-TVL/E TVL	20.55	0.65	32.17	0.34	2.19	0.12	14.53	28.68
OVS/OFS	5.08	10.27	20.71	0.26	2.62	0.16	41.96	16.98
PWV	9.39	0.00	66.95	0.45	1.87	0.06	20.04	0.96
W-KAAP/W CAPE	0.00	0.00	79.16	0.45	5.49	0.00	7.14	6.96

Figure 5.2: Example of query response

Two other phases of the web site development were proposed but could not be pursued further due to financial constraints.

Proposed phase two: On-line graph generation

In this phase of the development, it was envisaged that the site could gain the ability to generate graphs on the fly. Graphs would be generated from requested data, with users having the ability to specify the sort-orders, titles, etc. This phase could be a simple bar-chart produced for one variable in a query, or it could include a sophisticated graphing system, where users could even specify the type of graph they desire, with multiple series on a single graph. Users could thus save the images directly from their web browsers and use these images in their own documents or presentations.

Proposed phase three: On-line GIS integration

The third phase of the NDEUD web site could involve incorporating a GIS facility. An example of such a system can be found on the Internet at:

http://maps.esri.com/ESRI/mapobjects/tmap.htm

This example presents demographic information for any state in the United States of America. The images can be saved directly to one's computer from the browser. The

ability to generate such maps for web servers is becoming increasingly easy. The Environmental Systems Research Institute in the USA produces a product called MapObjects Internet Server that powers the site mentioned, and their ArcView Internet Server is now available on the market. Since this project already possesses a copy of ArcView and the NDEUD already works with ArcView, it makes sense to use this technology to make the GIS facility available on the web. The ArcView would however need to be upgraded to version 3.0 to be compatible with the ArcView Internet Server. This technology is available on both Windows and Unix platforms.

6.
Data analysis and synthesis

6.1 Introduction

One main output of the project was the extensive analysis and synthesis of the data in the database to establish whether there are some relationships between energy demand factors of the household sector and socio-economic characteristics of the household. To simplify the data presentation in this report, most of the data for the analysis have been drawn from the primary data component of the database (i.e. mainly from the Saldru data set[4]). As described in the 1995/96 progress report on this project, the Saldru data set was collected in a national survey in 1993. Thus this survey had a better coverage of the country than many of the secondary data sources put together. Secondly, analysis of the Saldru data set is less complex than that of the secondary data set[5] since, in the case of the Saldru data set, one would have to deal with one research methodology covering almost the same period of time with the same basis of measurements and definitions. Whilst the secondary data set mainly covers low-income households, the primary data set involves households at all income levels. It must be mentioned, however, that the primary data set (Saldru data set) was a little biased in favour of households dwelling in formal houses. In the case of the secondary data set, data presentation often requires extensive presentation of the background of the data sources as well. Since the secondary data set is a combination of many surveys undertaken during different periods of time with different research objectives, data gaps are a rampant phenomenon. On the other hand, the primary data set was collected in a national survey just before the first democratic elections in South Africa in 1994. Thus, in spite of its slight bias towards formal houses, it offers useful indicators for tracking change in the new South Africa.

In most of the studies from which the secondary data set has been extracted, there is insignificant cross-tabulation of energy demand and supply variables with income distribution. Thus, it is impossible to analyse the data based on income distribution. However, one major useful basis of analysis for this data set is dwelling type categorisation, though quite a number of the studies did not provide any information on the dwelling types of the households. In cases where the dwelling type information is not extensive enough, the background information on the study in the report is used to re-organise the provided dwelling type information into the required classification. Thus, the secondary data set was specifically suitable for the methodology for the energy demand projections in the project on *Domestic energy use analysis for sustainable development* (Afrane-Okese 1996) funded by Eskom Technology Research Investigations (TRI). The main disadvantage in this case is that

[4] This refers to a World Bank study on *Statistics for Living Standards and Development in South Africa* conducted in 1993/94 by the South African Labour and Development Research Unit (Saldru) at the University of Cape Town.

[5] The secondary data set comprises data extracted from reports on various studies on household energy use in different parts of the country.

a lot of useful data had to be left out if they could not be categorised into any of the pre-determined dwelling types.

6.2 Basis of analysis

Income-based analysis

Unlike the secondary data set, the primary data set offers the possibility of cross-tabulation of energy use variables with household income or expenditure. In this way, energy use variation with household income can be assessed in the data analysis. Thus household income has been used extensively as a basis of analysis in this study in order to assess the effect of household income on energy use in the household.

There are a few assumptions that have been made in the income-based analysis of the primary data. Unlike the household expenditure data, the household income data in the Saldru data set was found to be largely inconsistent and, in many cases, unrealistic. The indication is that the respondents were a bit hesitant to release the truth about their incomes. The survey was conducted during the few months leading to the first democratic elections in South Africa and, in such a volatile situation, many people were apparently sceptical about the future and could hardly trust interviewers with information about their income.

Household income and expenditure are not always the same even when the irregular expenditures like donations, remittances, savings, health costs, vehicle and appliance repairs, etc., are taken into account. Although it looks very expedient that the more income one receives the more one can give donations to charities, or remit to relatives or probably save, the human nature can be so unpredictable that it does not necessarily happen that way. However, most of the common household expenditures may seem to have some proportional relationship with income. Hence, for the sake of reliable analysis, this study chooses total household expenditure as the basis of analysis and synthesis instead of total household income. Hence, in this chapter, household expenditure is assumed to be directly proportional to household income and, therefore, household expenditure has been used in the analysis as an indicator of household income.

The income categories for cross tabulation of the data have been shown in Table 6.1 and these are arrived at as follows:

- First, to avoid the influence of different household sizes on household expenditure, per capita total household expenditure is used. This is achieved by dividing each total household expenditure by the particular household size.
- Second, R100 monthly per capita household expenditure in 1993 is used as the range of different income categories.
- Third, since this study focuses on low-income households, an attempt is made to avoid a bias by extraordinary higher income households and those respondent households with over-estimated household expenditures. To achieve this, households with per capita expenditures exceeding R2000/month were assumed to belong to this group and therefore conveniently excluded in all analysis based on income distribution. About 5% of the sampled households were excluded in this way from all analysis based on income distribution. It is worth mentioning here that about 87% of the households excluded from the analysis due to

extraordinary high household expenditures were White households, even though Whites constitute not more than 15% of the South African population. It must therefore be borne in mind that the analysis of the energy use patterns of white households in this report represents only a small minority of Whites whose household incomes or expenditures are comparable with the vast majority of the population.

Income category	*Per capita expenditure level (R/month)*
1	Less than 100
2	Less than 200
3	Less than 300
4	Less than 400
5	Less than 500
6	Equal/Above 500

Table 6.1: Income categories for the primary data analysis

Analysis based on urbanisation

The data has also been analysed in terms of rural, urban and metropolitan areas in order to identify the differences in the energy use of households in the different environments. In some cases where the differences between urban and metropolitan areas look very grey they are combined as non-rural. The main problem here is the distinction made between what was rural and what was not. This distinction is still not very clear and this can be the main source of errors in the analysis based on urbanisation. Rural areas were largely considered as settlements with no local authority during that period of the survey. Metropolitan household samples were drawn from Cape Town, Johannesburg, Pretoria, East London, Port Elizabeth and Durban.

Analysis based on the apartheid system of regions

Even though apartheid is formally gone in a democratic South Africa, the damage done to disadvantaged communities in certain geographic locations in terms of energy provision will not vanish easily unless the situation is constantly assessed and policies reviewed accordingly to avert the situation. It is for this reason that the data has also been analysed in terms of the old apartheid provinces and the so-called homelands. The Old Provinces embody all the areas that used to be referred to as the Republic of South Africa under the apartheid system. The Homelands in this report include the TBVC[6] states and all the so-called self-governing states[7]. Although the apartheid legacies in the homelands and the self-governing states are not necessarily the same, the two categories have been put together here for simplicity sake. The Old Provinces and the Homelands have been compared with the overall situation in the New Provinces of the present dispensation.

Analysis based on electrification

The extent of electrification has also been examined amongst different income groups, rural and non-rural areas, and different population groups.

[6] The TBVC states refer to the Transkei, Bophuthatswana, Venda and Ceskei homelands.

[7] The self-governing states were KwaZulu, KaNgwane, Qwa Qwa, Gazankulu, Lebowa and KwaNdebele.

6.3 Analysis and synthesis

The basis of the data analysis and synthesis in this section has been outlined in Section 6.2. The outputs of the data analysis and synthesis presented below in this section of the report are a selected portion of the extensive work done in this area. More detail outputs can be found in a Masters thesis based on this project (Afrane-Okese 1998a).

6.3.1 Background information: Socio-demographics

The understanding of the population composition of a nation is very important in household energy policy analysis. It facilitates the identification of energy demand and supply factors among different population groups and provides the necessary background information as a check on how policy is shaped to avert inequities in energy provision. The specific characteristics of the traditions of different population groups may influence their energy use patterns. Appropriate policy instruments would therefore have to be put in place in order to achieve equity across the different population groups.

To begin with, it is important to assess the authenticity of the data overview in this chapter by examining the extent to which the sampled households are representative of the South African population in general. Since the secondary data set consists of many studies with different sampling methodologies, it is a little complex making such an assessment. However, for the primary Saldru data set that consists of data collected in a once-off national survey, it is more straightforward assessing the data representativity of the population.

It must be mentioned that about 5% of the Saldru data was excluded from all the data analysis based on income distribution in order to avoid over-shadowing of the energy use patterns by upper higher income households. It is therefore worth knowing the population distribution of the data excluded. This helps in substantiating the reason for the exclusion and also to facilitate any later inferences that may be necessary when it becomes imperative to extrapolate the analysis to include the excluded data.

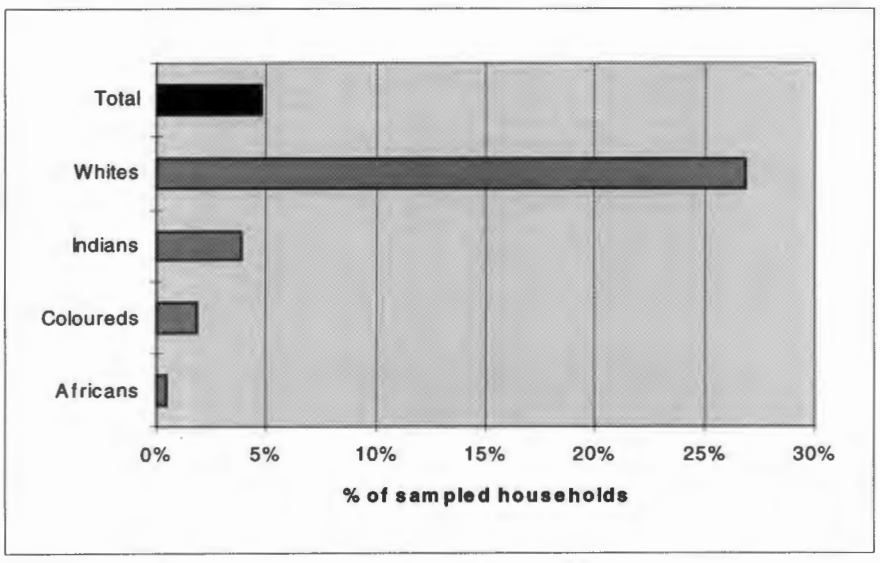


Figure 6.1: Percentage of sampled households excluded from the Saldru data analysis

Figure 6.1 shows the racial distribution of the data excluded from the Saldru data analysis. This figure typifies the skewness of income distribution as one main feature of the South African household economy. The extent to which the income-based exclusion affects the different races is in the decreasing order for Whites, Indians, Coloureds and Africans as widely known in the South African population. While the percentages of sampled African, Coloured and Indian households excluded from the analysis are relatively very small (all under 5%), the percentage of the White households excluded is significantly high. It is therefore very important to remember that, based on income distribution, about 27% of the White population are beyond the Saldru data analysis in this chapter. This will help to focus the analysis on the low-income households and also avoid making distorted conclusions about the energy use patterns of low-income households.

6.3.2 Distribution of the different races in rural, urban and metropolitan areas

Figure 6.2 depicts the distribution of the sampled households in the Saldru data set. It must be mentioned that none of the data was excluded in this analysis and that this is a true reflection of how representative the sample is of the population in terms of racial groupings and the distribution among rural, urban and metropolitan areas.

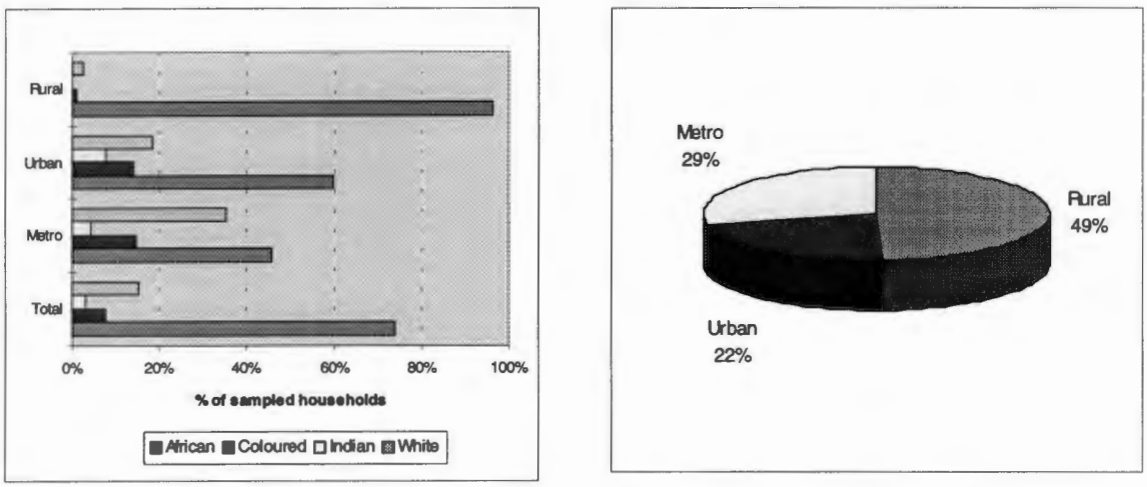


Figure 6.2: Distribution of the different races in rural, urban and metropolitan areas

Source: Saldru data analysis

The pie chart in this figure shows that, in 1993 (i.e. the year in which the data was collected), about 49% of South African households lived in rural areas, leaving about 51% urbanised. These percentages compare very well with data in a 1995 publication by the Central Statistical Service (CSS). While the CSS (currently called Statistics South Africa - SSA) publication (Central Statistical Service 1995) puts the rural component of the population at about 51% in 1991, the urban component is stated as about 49%. However, it is widely believed that urbanisation increased dramatically from the period when all political prisoners were released from prison and most oppressive laws of apartheid were repealed to the period of democratic elections and governance. Thus, it could be that urbanisation might have increased by 2% from 1991 to 1993 leaving the rural households at about 49%. On other hand, the indistinct divide between rural and non-rural households in the sampling methodology might have contributed to the 2% discrepancy. Furthermore, the difference might be due to the fact that the CSS rural and non-rural distinction is

based on individuals rather than households. The Nelf Demand-side Database (Nelf 1994) also gives the rural households' component as about 47% leaving about 53% of the households urbanised. The recently released SSA census puts the urban:rural ratio at about 52:48 (CSS 1998). On the whole, it could be concluded that the urbanisation distribution of the Saldru sample is fairly close to existing data.

The bar chart in Figure 6.2 illustrates how the Saldru data set reflects the racial groupings in South Africa in terms of rural, urban and metropolitan areas. The figure shows that, of the total sampled households, 74% are Africans, 15% are Whites, 8% are Coloureds and 3% are Indians. The existing data sets are usually based on population and therefore do not offer a common basis for comparison. For example, an African National Congress Women League publication reflects the racial breakdown of the South African population in 1990 as 75.5% African, 13.3% White, 8.5% Coloured and 2.7% Indian (ANCWL 1993:5). Similarly, computations from figures in the CSS publication (CSS 1995) results in a 1995 mid-year population distribution of 76% African, 13% Whites, 8.5% Coloured and 2.5% Indian. These population figures represent the African percentage a little bit higher and the White percentage a little lower than the household breakdown from the Saldru data set. The explanation for the little differences could be that majority of African households generally have household sizes higher than Whites as has been made clear by Afrane-Okese (1998: 68-70). Thus, the racial disaggregation of the Saldru data comes very close to existing observations and this goes to prove how well the Saldru data represents the South African households in terms of racial groupings.

When the upper higher income households are excluded from the sample, the racial distribution of households looks like Figure 6.3. It must be noted that it is this racial distribution of the households which will be inherent in subsequent income-based analysis of household energy use variables in this chapter. Besides the distribution of the total sampled households amongst the different races, the bar chart in Figure 6.2 also depicts the extent of urbanisation of the different racial groupings. The main observation from the graph is the influence of urbanisation on the racial composition of the population.

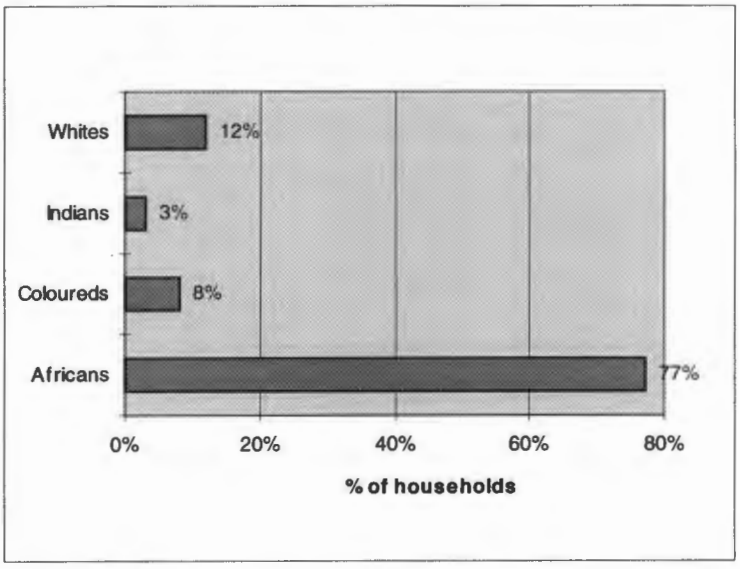


Figure 6.3: Racial distribution of sampled households with the upper higher income group excluded

It is interesting to note that, the higher the extent of urbanisation (i.e. from rural, urban to metropolitan areas) the less the composition of African households. It can be seen from the graph that, while about 96% of the sampled rural households are African, about 60% and 46% of the sampled urban and metropolitan households respectively are African. For the sampled White households the trend is completely opposite. While 35% of the sampled Metropolitan households are White, about 18% and 3% of the sampled urban and rural households respectively are White. Most of the White households living in rural areas are likely to be commercial farmers. For the sampled Coloured households, there is no significant difference between the compositions of both the urban and metropolitan households (i.e. about 15%). The 1% Coloured households in the rural areas could be largely farmworker households. Figure 6.2 shows that the composition of rural Indian households among the sample is virtually insignificant and that the urban households have an Indian composition (8%) a little bit higher than the metropolitan composition (4%).

The foregoing discussion shows that the racial groupings to which households belong have had great influence on where people live and the extent to which they are urbanised. This has emanated from the racial segregation policy under the erstwhile apartheid government that has obviously had an impact on the access of households from different racial backgrounds to energy resources and services.

Racial differences in income distribution

The skewness of income distribution among different racial groupings in South Africa is made vivid in Figure 6.4. This figure represents the total sampled households with no exclusion of the upper higher income households depicted in Figure 6.3.

The most interesting aspect of the graph is the split of the total sample into distinct socio-economic entities along racial lines, with each race having its own trend of income distribution. A careful examination of the trends reveals that the African households are far worse off in terms of income groupings, followed by the Coloured, and then the Indian households. For lower income groups, the percentage of African households exceeds that of the average for the total sample till the fifth income group where it equalises with the average for the population. At the sixth income group the percentage of African households falls below that of the total population.

The Coloured households seem to be a little better off than the total population for the first two income groups with lower percentage of households than the total population. For increased income levels from group three to group five the percentage of Coloured households stays above that of the overall population. At the sixth income group, even though the percentage of Coloured households is far above that of the African population, it still remains below that of the general population.

There is no Indian household in the lowest income group. From the second income group the percentage of Indian households rises gradually past that of the overall population at the fourth income group and jumps from the fifth income group to over 60% at the sixth income group. In fact, over 75% of the Indian households seem to be in the fifth and the sixth income groups. For the White households, over 95% are in the highest income group, leaving a mere less than 5% spread evenly among the lower five income groups.

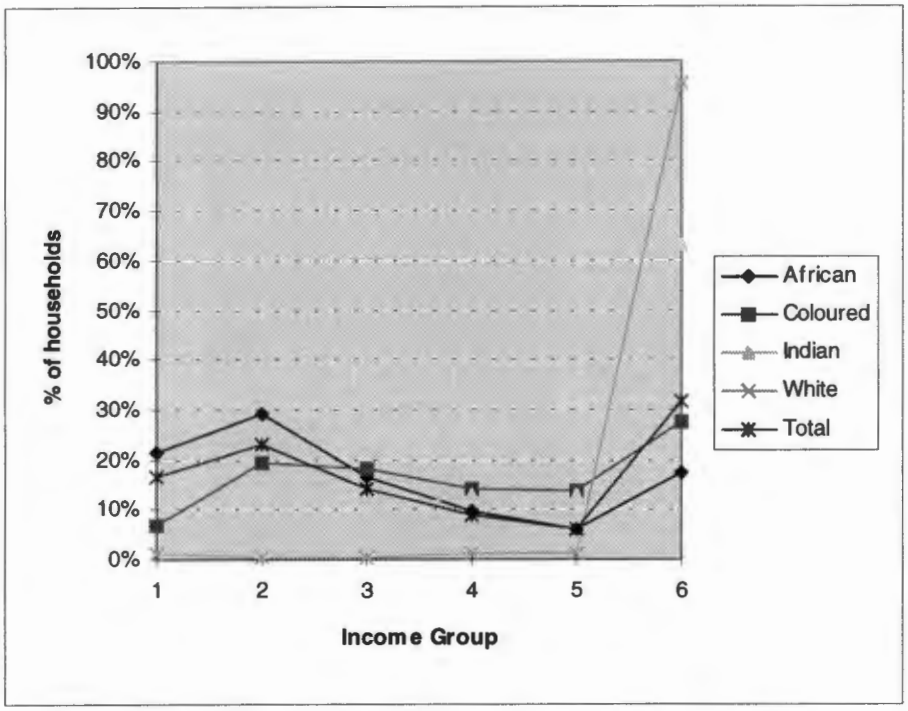


Figure 6.4: Income distribution of total sample along racial lines

Now, to simplify the analysis, let us assume that income levels one to three constitute lower income group with monthly household expenditure not exceeding R300[8] per capita. Similarly, let us assume that income levels four and five constitute the middle income group with monthly per capita expenditure not exceeding R500, and income level six constituting the higher income group with monthly per capita expenditure exceeding R500. This will mean that the African households, which are the majority of the population, are mainly lower income households with about 67% occurring in that group. The rest of the African households are distributed almost equally among the middle and the higher income groups (i.e. 16% and 17% respectively). The percentage of lower income Coloured households (44%) is also reasonably higher than those in the middle and higher income groups. The middle and higher income Coloured households are almost equally distributed (i.e. 28% and 27% respectively). The Indian households seem to have very small lower income group (12%), a slightly bigger middle income group (26%) and a substantial higher income group (63%). The White population is mostly in the higher income group (95%) with about 2.5% in the lower and middle income groups each.

It is important to bear the above income inequalities in mind when analysing energy demand and supply factors. It is clear from the above figure that the South African society has a very slim middle income group (about 15% for the total population) compared with the lower income group (about 53%), yet the high incomes of a minority of the population in the higher income group (about a third of the population) distort the overall income per capita picture. Energy policy formulation must address these inequalities, and energy service provision must incorporate the necessary policy instruments that deal with the inherent affordability issues.

[8] The value of the Rand mentioned in this analysis refers to 1993 value.

Income distribution of metropolitan, urban and rural households.

The extent to which income distribution is skewed also differs a little depending on whether a household is located in a metropolitan or urban or rural area. Figure 6.5 shows the differences in the income distributions of households in metropolitan, urban and rural areas.

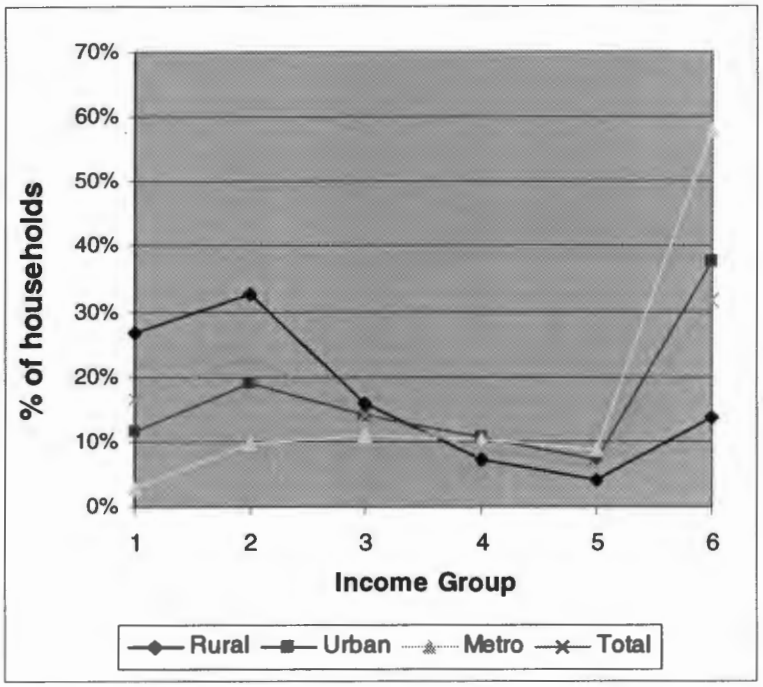


Figure 6.5: Income distribution of rural, urban and metropolitan households

First, comparing the total sample and the metropolitan households in Figure 6.5, it can be seen that households in the metropolitan area are better off in terms of income distribution than the overall situation in the country (i.e. than the rural and urban households). While about 58% of the metropolitan households are in the top income group (i.e. Income Group 6), only about 32% of the overall sample happen to be in this group. Second, for the lower and middle income groups, while the percentage of the total sample rises from about 17% to about 23% at the second income group, and falls gradually to about 6% at the fifth income group, the percentage of metropolitan households rises from a mere 3 % to about 10% at the second income group and stays almost constant till the fifth income group.

For the urban households, if the total sample and the urban households in Figure 6.5 are compared, it can be seen that urban households are a little better off in income distribution than the overall situation but not as much as the metropolitan households. In the lower income group, the percentage of urban households is found below that of the total sample whilst in the higher income group the reverse is the case.

For the rural households sample, the lower income group (i.e. income groups 1 - 3) constitutes about 75%, the middle income group 11% and the higher income group about 14%. This shows the extent of poverty among rural households and it is therefore obvious that affordability will be a major constraint to energy provision to the rural households.

6.3.3 Fuel use variation with income.

Figure 6.6 depicts the overall picture of the extent to which different fuels are used amongst households in different income groups in South Africa. With respect to fuel use variation according to income, the six domestic fuels in Figure 6.6 fall into three main categories. Paraffin, candles and wood fall into one category that is clearly shown to be consisting of fuels predominantly used by the poor. These fuels are used extensively at lower income levels (for example, 73-80% of the households in income group 1, 60-78% of households in income group 2, etc.). However, as household income increases their usage diminishes. The degree to which the use of these fuels of the poor diminishes with income rise is not the same for all the fuels. Whilst paraffin and candles seem to have a gradual fall in their use as income levels rise, wood use falls steeply with income level rise. The use of paraffin and candles falls from about 78-80% at income group 1 to 23-26% at income group 6 whilst wood use falls from about 73% at income group 1 to about 5% at income group 6. Of the three fuels in this category, it appears that wood is the least preferred as household income is improved. This may be due to the dwindling availability of wood in certain parts of the country and the inconvenience involved in its collection and use compared with paraffin and candles.

The use of paraffin and candles is surprisingly high even amongst the top income group (23-26%). There could be two reasons for this. First, candles may be used amongst higher income households mainly for the dining table and some minor celebrations like birthdays. Second, the high paraffin use in higher income households could be an indication of the extent to which the lack of access to electricity can be a barrier to even those who may be able to afford the electricity supply service.

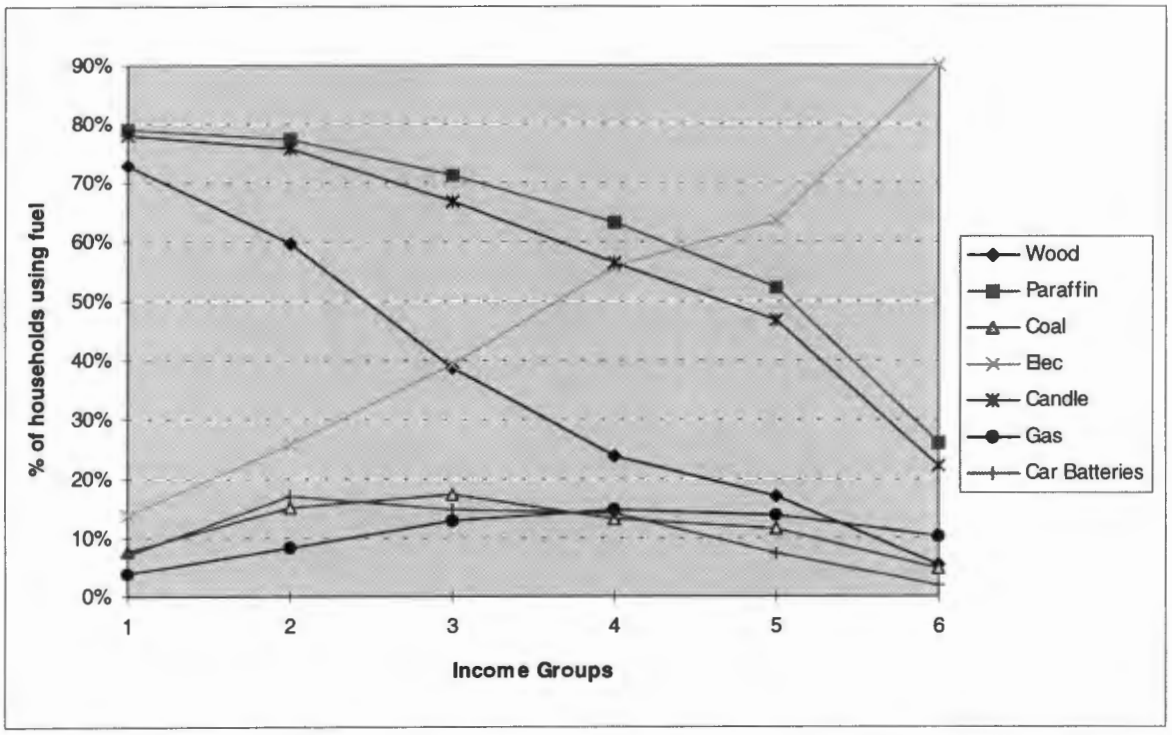


Figure 6.6: Percentage of the households in each income group in South Africa using a particular fuel

Electricity makes up the second category. In this case the extent to which electricity is used amongst the households increases almost linearly with income levels. This is obviously due to the fact that, as household incomes are improved electrification becomes affordable and households then tend to shift from the use of fuels in the first category to electricity. Thus electricity is largely shown to be the fuel of the rich.

The third category in Figure 6.6 is made up of the fuels of the minority, which are LPG, coal and car batteries. Their use in all the income groups is very low and does not exceed 18% of the households in any income group. Their curves have maximum points which means that, as income improves more households are able to afford the use of the fuels till the point where they shift to other fuels and their appliances which become affordable as well at higher income levels, especially electricity and electrical appliances. From the figure, it appears like income enhances the affordability of LPG supply service more than the other two fuels in this category since LPG's maximum point occurs at a higher income level (Income Group 4) than coal and car batteries. This is probably because LPG has many desirable characteristics as domestic fuel like convenience and cleanliness. Perhaps the main problems with it are reliability of supply and versatility when it is compared with the wide range of appliances that can be used with electricity. Higher income does not seem to influence the affordability of car batteries very much as the maximum point (about 17%) is reached at income group 2. From then on its use drops heavily to about 2% at income group 6, indicating shifts to other fuels more convenient, efficient and affordable. The extent to which income affects household choices for coal use seems to lie between LPG and car batteries.

6.3.4 Multiple fuel use

From Section 6.3.3 it can be shown that the sum of the percentages of households using different fuels at any income level far exceeds 100%, which gives an indication that multiple fuel use is a common phenomenon in South African households. The extent of this phenomenon amongst South African households is explored further in this section and the fuels involved are also identified. The effect of income levels of households on multiple fuel use is also briefly analysed.

Figure 6.7 depicts multiple fuel use patterns for overall South Africa, areas in the former homelands and areas in the former provinces. It can be seen from this figure that only about 32% of the households in South Africa are able to depend on one fuel in meeting their daily energy needs, the rest depend on combinations of 2 or more fuels. The most common phenomenon of multiple fuel use is the combinations of 3 fuels (about 30% of all South African households) compared with the combinations of 2 fuels (about 23%) and of 4 or more fuels (15%).

The fuels involved in the single and multiple fuel use in overall South Africa have been illustrated in Figure 6.8. It can be seen that single fuel users are largely electrified households using electricity. However, it is clearly shown here that electricity is not only used as a single fuel but also in combinations with other fuels. In fact, almost half of the electricity users use it in combination with either one or two or more fuels. Apart from electricity, paraffin is the only other fuel that is significantly used as a single fuel but that is limited to only about 3% of all households. For households using combinations of two fuels, the fuels involved are mostly paraffin and candles, and to a lesser extent wood and electricity as well as very few households using coal or LPG. For those using combinations of three fuels, the fuels involved are mainly paraffin, candles and wood. The combinations of electricity with

two other fuels is also quite significant (about 9%) but only few households combine coal or LPG or car batteries with two other fuels. All the seven fuels under discussion seem to be involved in 4-fuel combinations but candles, paraffin and wood appear to dominate.

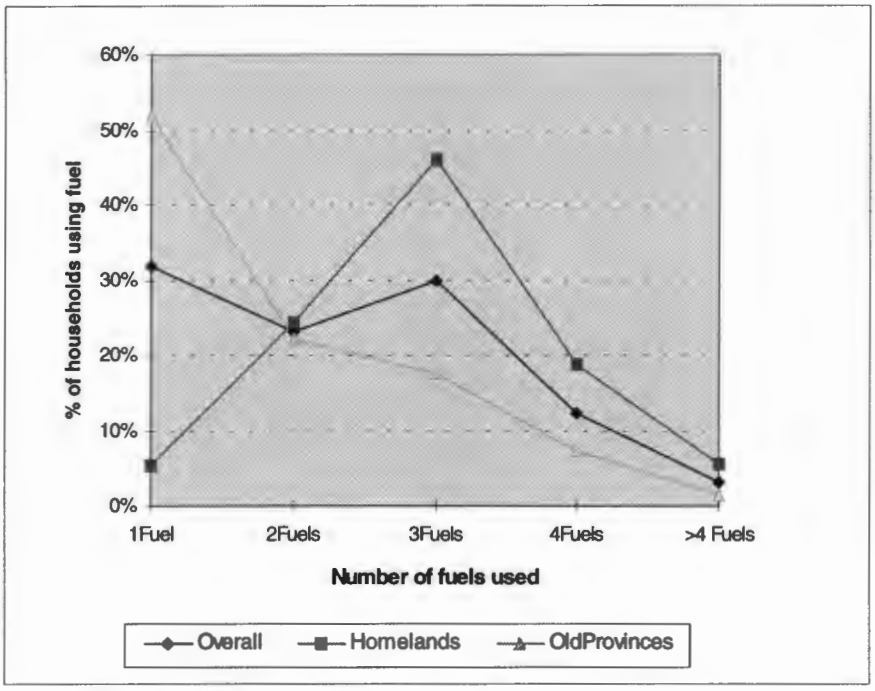


Figure 6.7: Multiple fuel use in the overall South Africa, areas of the former homelands and provinces

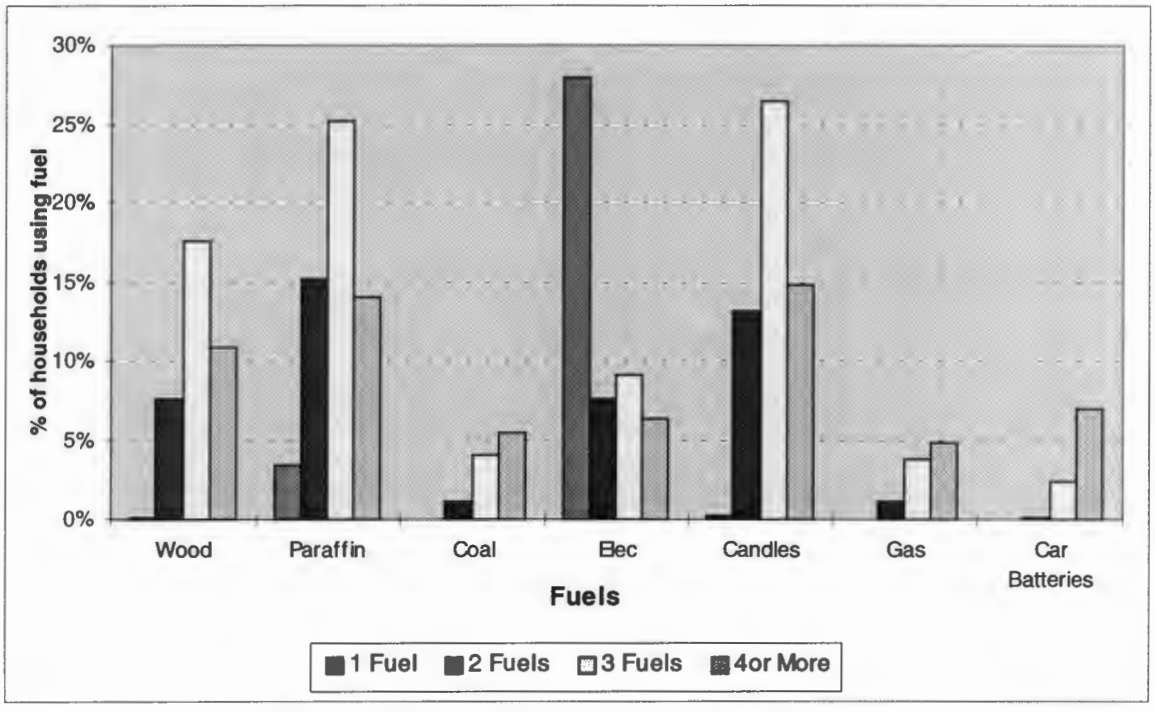


Figure 6.8: Overall fuel combinations in South Africa

Again, from Figure 6.8, multiple fuel use seems to be more pronounced in the areas of the former homelands than in the areas of the former provinces. Whilst over 50% of the households in the areas of the former provinces use a single fuel for their energy needs, about 95% of the households in the former homeland areas use 2 or more fuels for their needs. Further analysis shows that over 90% of the households who depend on a single fuel in the former provinces areas are users of electricity. It appears that extreme lack of access to affordable electricity provision in the former homeland areas has compelled the households to resort to multiple fuel use extensively as a survival strategy. Even for the 5% of the households in the former homeland areas who depend on a single fuel, only about half are electricity users; the other half entirely depend on paraffin. This shows that, to some extent, the limited electricity provision in the former homeland areas is either not affordable or appropriate or desirable by many households for all energy end uses. It is very clear that electricity use is cleaner and non-poisonous and one could hardly argue about the versatility of electricity in its applications and delivery to the point of use. The lighting provided by electricity is of higher quality and cheaper than that provided by other fuels like paraffin and candles. This makes electricity attractive to low-income households; however, the energy service from electricity for key domestic end uses like cooking, space and water heating is usually not affordable to poor households. For such end uses that are energy intensive, poor households often prefer to use other fuels which they find affordable regardless of the cleanliness or quality of the fuel.

In terms of the percentage of households using combinations of two fuels, Figure 6.7 shows that the difference between the former homeland areas and the areas of the former provinces is very slight. However, the fuels involved in the 2-fuel combinations are different. Whilst the fuels involved in the dual fuel use in the areas of the former provinces are mainly electricity, paraffin and candles, those involved in the former homeland areas are mainly paraffin, fuelwood and candles. The most common phenomenon of multiple fuel use in the former homeland areas is the combinations of three fuels but the use of four or more fuels in some households is also substantial.

Effect of household income on multiple fuel use in South Africa

Figure 6.9 gives an illustration of the relationship between multiple fuel use and household income for all South African households. It is clear from the graph that, for low-income households (from income group 1 to 3), the most common practice is the combination of three fuels. On the other hand, for the higher income levels (income groups 4 to 6), the most common phenomenon tends to be single fuel use. Combinations of two fuels, four or more fuels do not appear to have any strong relationships with household income.

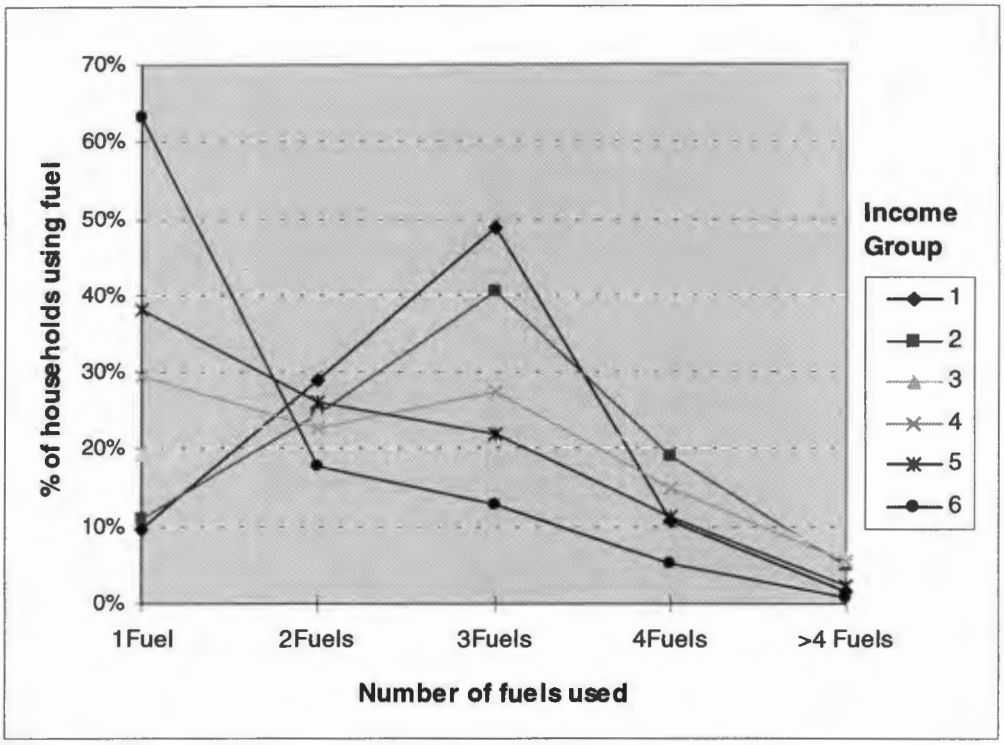


Figure 6.9: Overall multiple fuel use variation with income in South Africa

It can be seen from the graph that single fuel use becomes the preferred option for most households as income improves. Some higher income households, however, depend on a primary fuel as well some secondary fuels. On the other hand, there seems to be a negative straight-line relationship between the practice involving the combination of three fuels and household income. This means that households appear to opt out of the practice involving the combination of three fuels as their income situation improves. This is explained by the fact that, as income improves households are able to afford the cost of electrification, appliance purchases and electricity supply service or the bulk purchase of paraffin. Thus higher income households could depend solely on electricity or otherwise choose to depend solely on paraffin if they already own paraffin appliances and cannot afford the costs involved in electricity provision as well.

From analysis in Figure 6.10 concerning single fuel use variation with income, it can be seen that single fuel users tend to shift from paraffin use to electricity use as income improves. In fact, at income level 1, about 47% of the single fuel users are paraffin users but this decreases to about 2% at income level 6 since most households (98%) at that income level use electricity, for they obviously can afford it. Although improved income influences households greatly towards the use of electricity as a single fuel in households, there are reasons why multiple fuel use persists at higher income levels. Many households might have already spent a lot of money on appliances for the less desirable fuels like paraffin, coal and wood before their dwellings were electrified. Thus, it becomes burdensome for them to purchase another set of appliances for electricity use only. Even when they can afford the purchase of these electrical appliances, they tend not to use them for end uses like cooking, water heating and space heating which are energy intensive since other fuels appear to be more affordable. Furthermore, the use of some of these fuels could

be for multiple purposes, for example, cooking with fuelwood or coal stove could provide the necessary space heating.

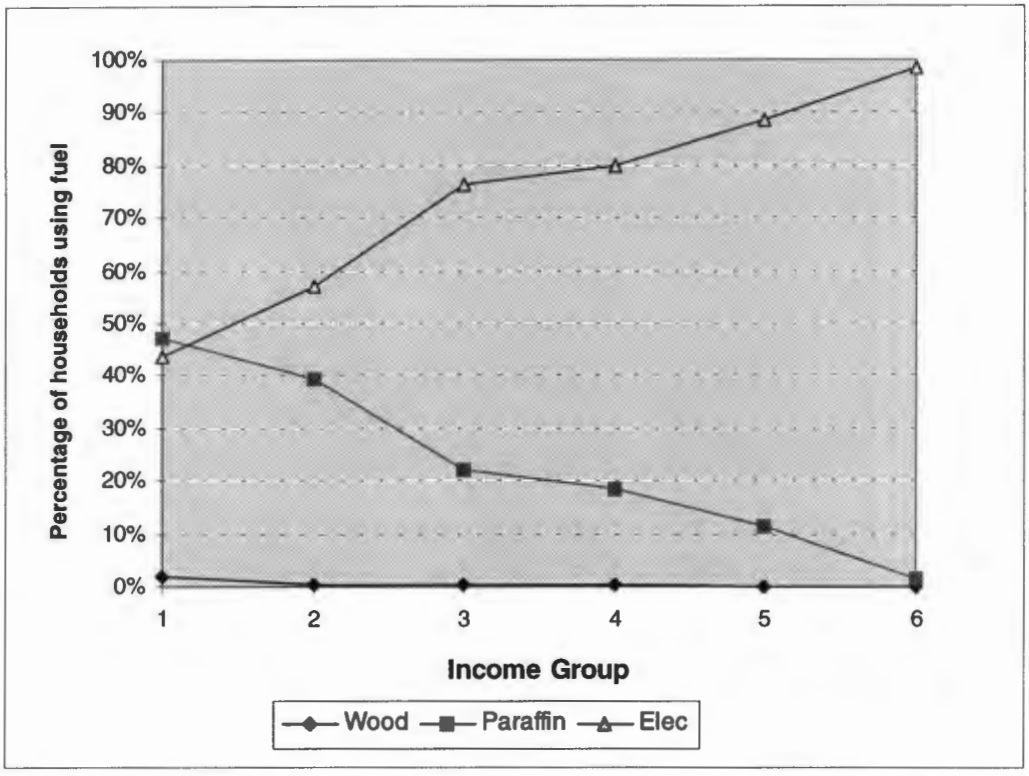


Figure 6.10: Single fuel use variation with household income in overall South Africa

6.3.5 Level of electrification of households in South Africa

Comparison of rural, urban and metropolitan areas

In Figure 6.11 it is shown that electrification in the rural areas of South Africa is far below that in the metropolitan or urban areas. Though 27% electrification of rural households shown in this figure is a little bit on the high side when compared with the 1995 figures by the NER (Du Plessis 1996), it is far below the over 60% and 80% electrification of urban and metropolitan households respectively. This is indicative of the levels of development in the rural and non-rural areas since electrification may lead to the establishment of other enterprises that depend on electricity.

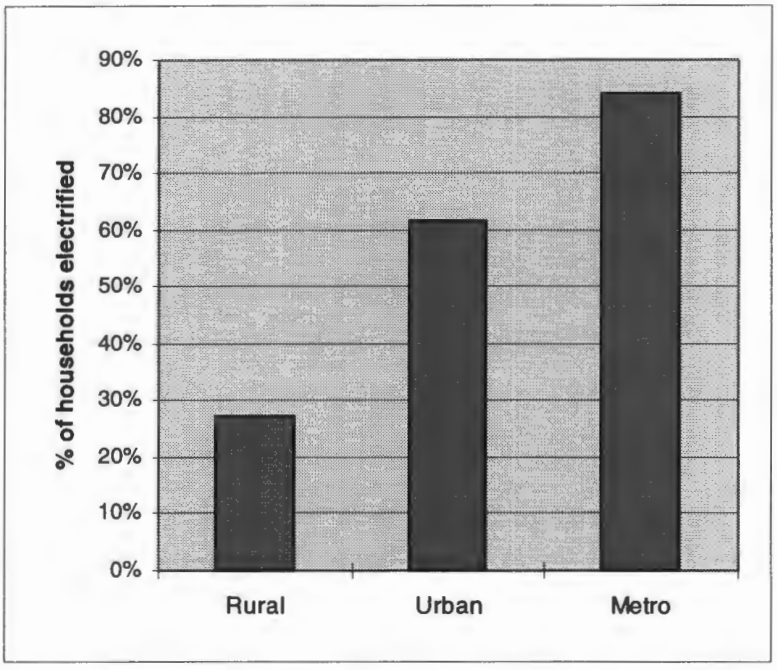


Figure 6.11: Percentage of households electrified in rural, urban and metropolitan areas of South Africa.

Figure 6.12 shows the influence of household income on the extent of electrification in the rural, urban and metropolitan areas of South Africa. With the exception of income group 5 of the urban households, the figure seems to show that the higher the household income, the more likely households are to be electrified in the rural, urban or metropolitan areas.

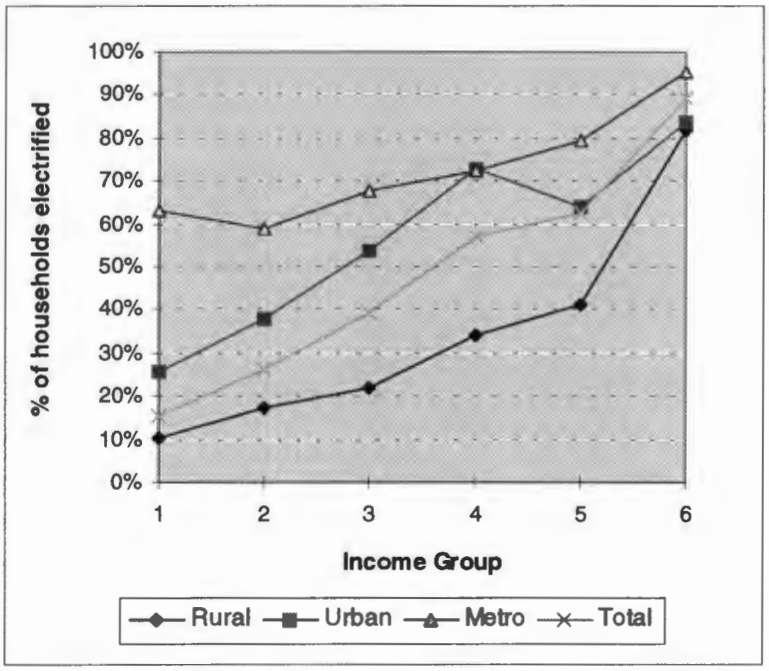


Figure 6.12: Percentage of electrified households in different income categories of rural, urban and metropolitan areas of South Africa.

Comparison of areas in the old provinces and the former homeland areas

In Figure 6.13, it is shown that electrification increases with household income level for overall South Africa, the old homeland areas and the areas in the old provinces. This shows that household income is one of the main factors influencing the electrification of dwellings whether in the areas of the former provinces or the former homeland areas. It can also be seen from the figure that, at any income level, electrification in the old provinces is higher than in the former homeland areas, although it must be remembered that most of the households in the homelands are in the first and second income levels.

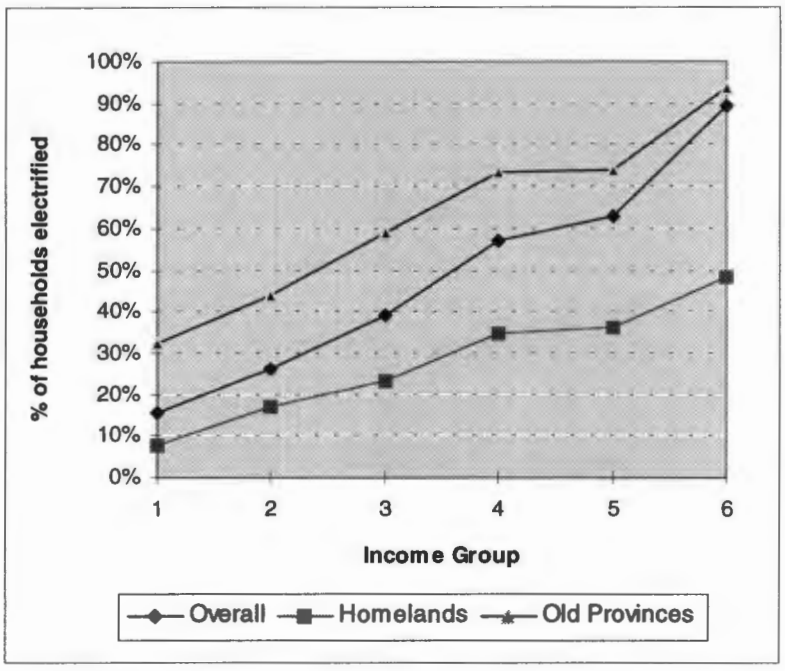


Figure 6.13: Percentage of electrified households in different income categories of overall South Africa, areas in the former homelands and the old provinces.

The gap between the electrification of the old provinces and that of the former homeland areas widens as income level increases. This indicates that the influence of household income on a household's access to electrification is less in the areas of the former homelands than in the areas of the old provinces. In the former homeland areas, the cost of electricity connection would be generally higher than the areas of the old provinces due to longer distances from the electricity grid. The quality of service in the homeland areas is also usually poor. Households in the homeland areas will thus consider these factors in their decisions concerning electrification.

For the non-rural households in the former homelands areas shown in Figure 6.14, the effect of household income on electrification seems to have a limit. It can be seen from the figure that electrification increases with household income level till the fourth income level. Beyond this income level, households who are able to afford other sources of energy like LPG may opt for such to avoid high electricity connection fees and poor level of service. Another reason why some high-income urban households in the homeland areas opt for other fuels rather than electrification of their households could be proximity to the distribution networks of these fuels. In such a

situation location becomes more important. For rural households in the areas of the former homelands, however, electrification is higher only amongst high-income households since only those can probably afford the high connection costs.

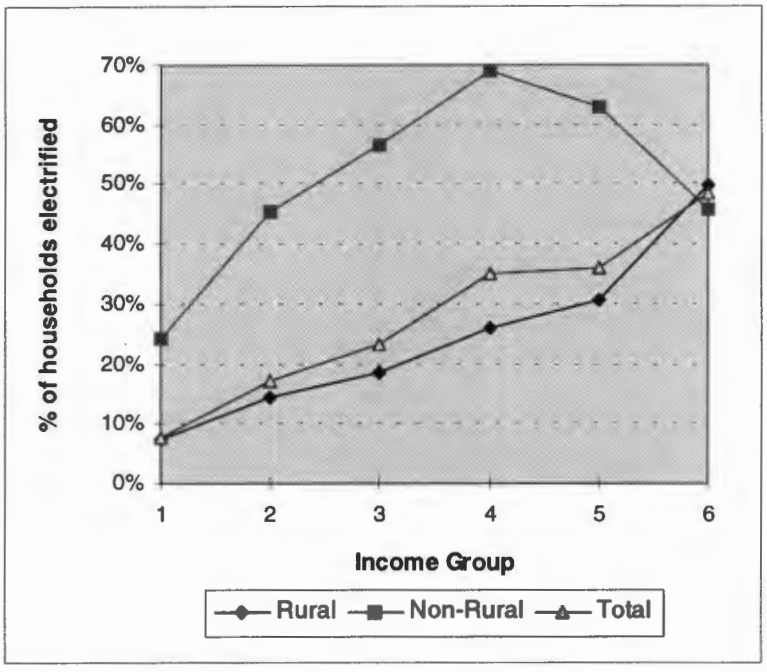


Figure 6.14: Percentage of electrified households in different income categories of rural and non-rural areas of the former homelands of South Africa.

6.3.6 Effect of household income on expenditure on individual fuels

Although the prices of fuels in different parts of the country may differ slightly from one another, the average monthly household expenditure on individual fuels presented in Figure 6.15 gives some indication of how intensively the particular fuels are used in the household. In the case of wood, it must be pointed out that what is presented in the figure may not be the complete picture since not all the fuelwood used in the households is purchased at some monetary value. In actual fact, many of the households using wood usually collect it from farmlands and woodlands.

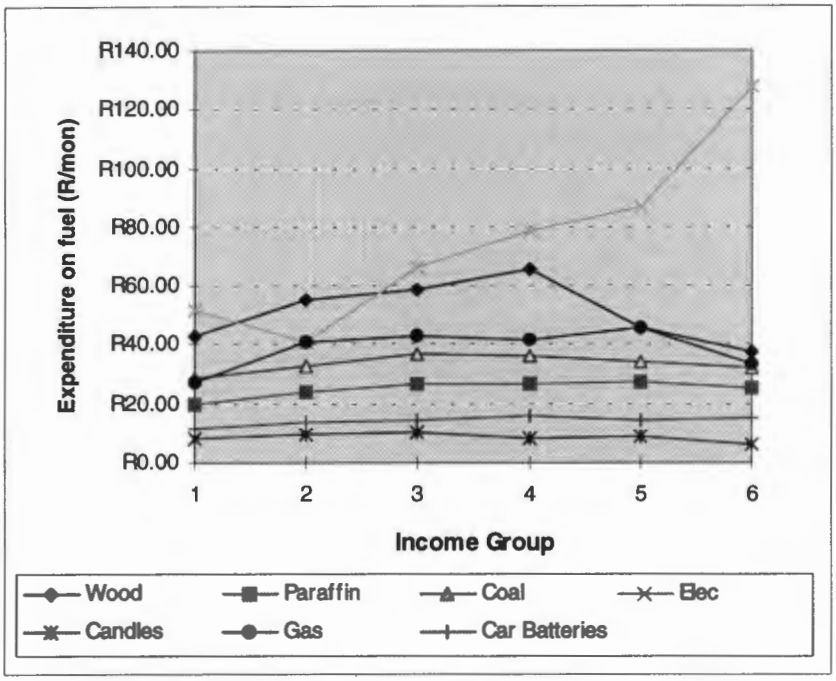


Figure 6.15: Average monthly expenditure on individual fuels by households in different income groups in South Africa.

The figure also shows the effect of household income on household fuel expenditures for the various fuels. In general, it can be seen from the figure that, apart from electricity and fuelwood, household income does not seem to have appreciable influence on the expenditure on the individual fuels. In other words, expenditure on fuels other than electricity is income inelastic, although fuelwood shows some minor elasticity towards income up to income level 4.

For households up to the fourth income level, fuelwood users are able to afford to spend a little bit more on wood purchase as their income increases, even though the number of households using wood generally decreases with household income (see Figure 6.6). Beyond the fourth income group, households seem to prefer to either shift completely or partially to other fuels, or spend less on fuelwood and more on other fuels like electricity.

Households do not only tend to shift from other fuels to electricity (see Figure 6.6) as their incomes improve but also they tend to spend more on electricity. Average monthly electricity consumption increases from about R40 in income group 2 to about R130 in income group 6. The drop in electricity expenditure from income group 1 to 2 is a bit odd. In general, it appears that the more income the households receive, the more they are able to afford the service and the purchase of more appliances. It is, however, not known whether increase in household income does not eventually lead to extravagant use of electricity that could create unnecessary load on electricity generation plants.

Figure 6.16 shows that, in the non-rural areas of South Africa (including metropolitan areas), household income does not appear to have any influence on the amount of money spent by households on any of the fuels, the only exception being electricity. This seems to suggest that households, irrespective of their income, would always find strategies of acquiring the required amount of fuels for their survival, except for

electricity. In the case of electricity the consumption by households is heavily limited by their income.

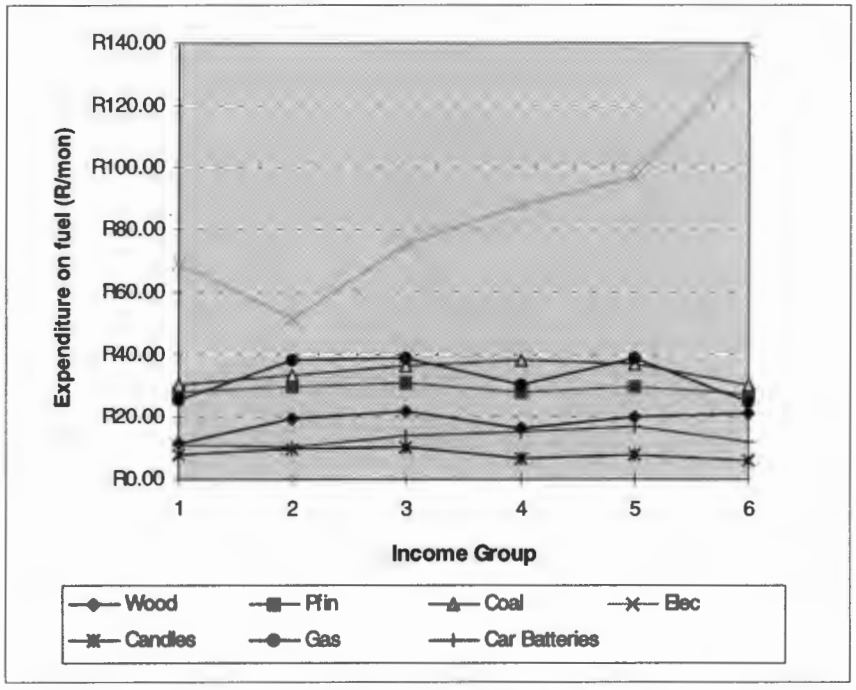


Figure 6.16: Average monthly expenditure on individual fuels by non-rural households in different income groups in South Africa.

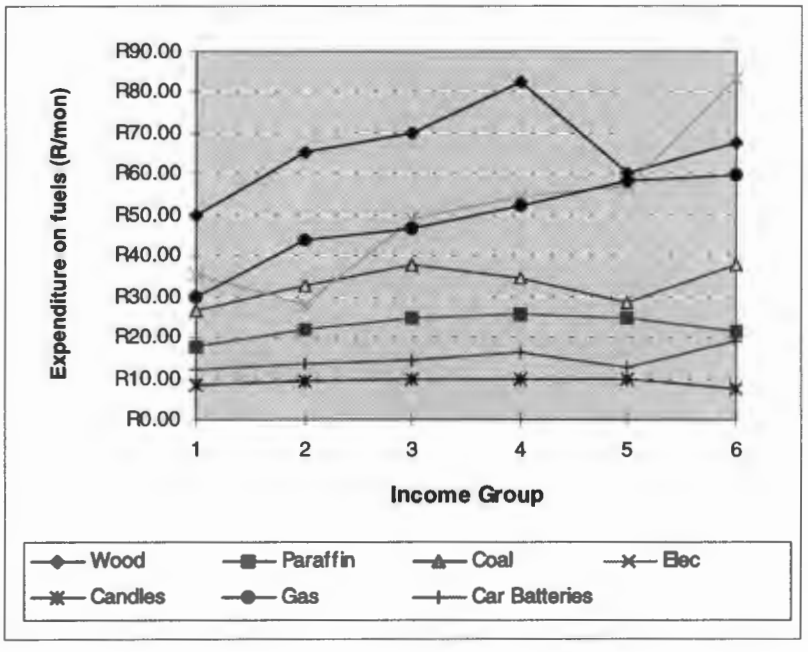


Figure 6.17: Average monthly expenditure on individual fuels by rural households in different income groups in South Africa.

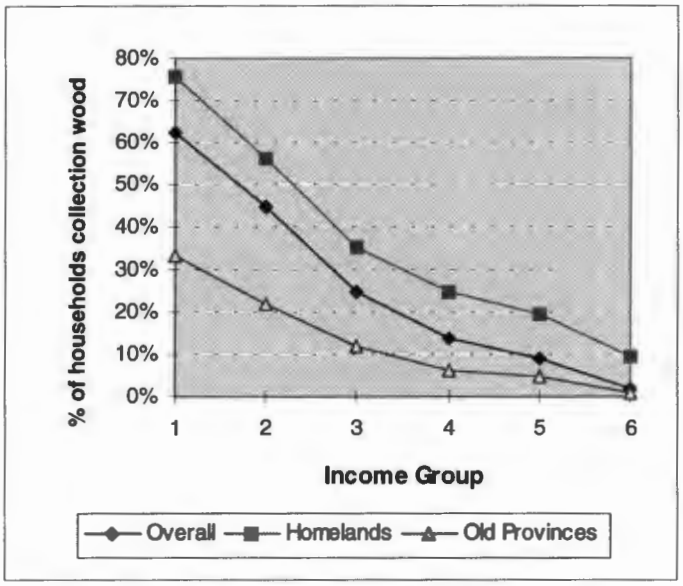


Figure 6.22: Percentage of households collecting wood in different income groups of South Africa

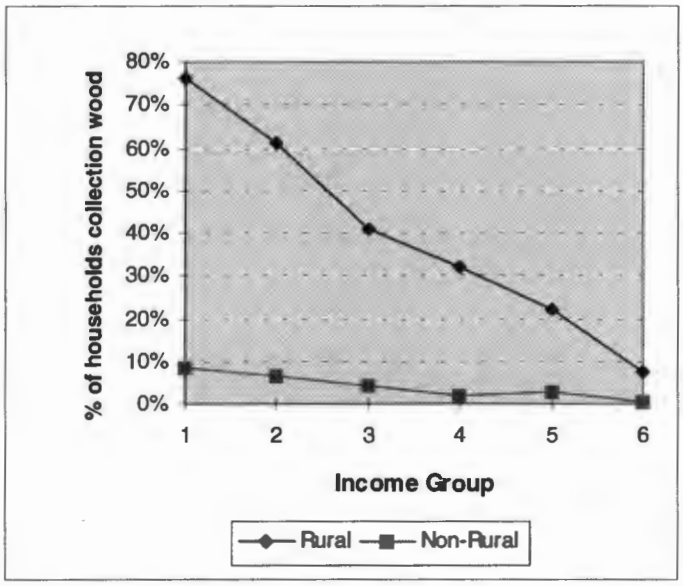


Figure 6.23: Percentage of rural and non-rural households collecting wood in different income groups of South Africa

Figure 6.23 also depicts that wood collection is not only mainly low-income household affair but also largely a rural activity. Whilst wood collection is below 10% even in the lowest income households in the urban areas, the activity is common amongst over 70% in the lowest income households of the rural areas and drops below 10% in the highest income group in the rural areas.

On the other hand, Figure 6.17 shows that, in the rural areas of South Africa, expenditure on (or in other words, consumption of) electricity, LPG and fuelwood are all influenced by household income.

In general, as household income improves in the rural areas, households are able to afford to spend more on electricity or LPG. Wood consumption also increases with household income but beyond the fourth income group households tend to either lower their consumption or shift to other fuels.

6.3.7 Total household expenditure on fuels

Variation amongst different income groups

Section 6.3.4 details the widespread multiple fuel use phenomenon in South Africa. In such an extensive multiple fuel use situation, expenditure on individual fuels which is discussed in the preceding section does not give a clear picture of the total household expenditure on fuels. Figure 6.18 presents a total picture of the variation of average total monthly household expenditure on fuels with household income for overall South Africa.

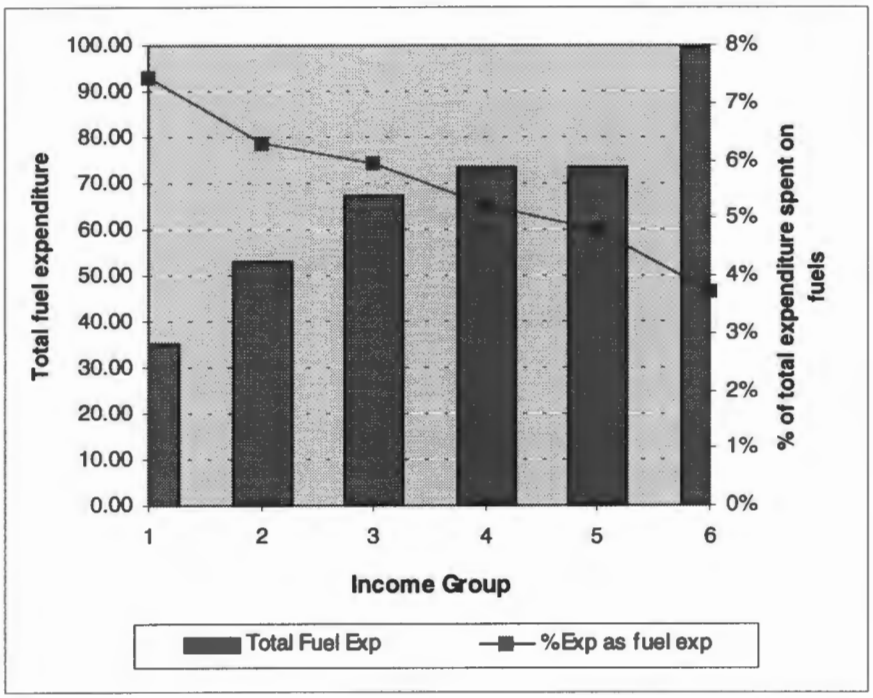


Figure 6.18: Average total monthly fuel expenditure by households in different income groups in South Africa compared with total monthly expenditure

The figure shows a general increase in average household total expenditure on fuels as household income improves. At the same time, it also depicts that as household income improves the lower the percentage of the total household expenditure spent on fuels. This paints an impression that lower income households feel the pinch of their expenditure on fuels more than the higher income households might.

Variation amongst different racial groupings

Energy use in South Africa is not only skewed amongst the different racial groups in terms of access to energy resources but also in terms of how intensively the energy is used in the households. Figure 6.19 shows a vivid illustration of the skewness of energy consumption amongst different racial groups in South Africa. The figure shows that White households spend more on energy in their homes than all the other races.

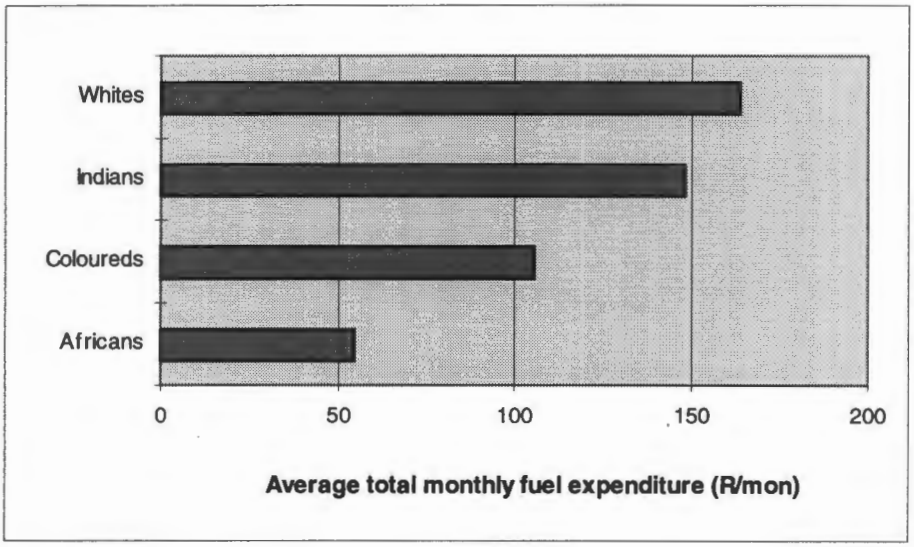


Figure 6.19: Average total monthly household fuel expenditure by different population groups in South Africa

This is followed by the Indian and Coloured households respectively with African households spending the least amount on energy. Whilst White households spend an average of about R164 per month on energy in the home, the Indian, Coloured and African households spend about R148, R106 and R55 per month respectively in the home. This is in spite of the fact that African, Coloured and the Indian households are generally larger in numbers than White households (see thesis mentioned in Section 6.3). Furthermore, it should be recalled that about 87% of the households excluded from this analysis due to extraordinary high incomes were White households (see Section 6.2). Now, if these excluded White households (which constitute about 27% of the total sample of White households) are included in the analysis, the true average amount spent by White households on energy is over R190 per month. The differences in energy expenditure amongst the different races are not likely to be due to mere differences in prices at which the different racial groupings purchase their fuels. This is because it can be argued that Africans inhabit the most remote areas in the country where prices are likely to be higher due to lack of access to the fuels, more than any other racial group.

One probable explanation for the different expenditures by the different racial groups could be that the different fuels are not used by the different racial groups to the same extent. Further analysis shows that almost all White and Indian households are electrified whilst about 85% and 35% of Coloured and African households respectively are electrified (see thesis mentioned in Section 6.3). It follows that whilst the White and Indian households are largely dependent on electricity, African

households are mostly dependent on other fuels like paraffin, coal and wood. But in Figure 6.15, household expenditure on electricity in the high-income groups is shown to be very high compared with the other fuels. Since White households, and to some extent Indian households, are mostly in the higher income groups, it is not very surprising that their total expenditures on energy in the home are that much higher.

Figure 6.20 depicts the variation of total energy expenditure with household income amongst the different racial groupings. The Indian and White households do not have relevant data for the first 2 and 3 income groups respectively since data on those income groups is scanty. It must also be mentioned that the average total fuel expenditure of the African households would be a little higher than that shown in Figure 6.20 if collected fuelwood were given some monetary value.

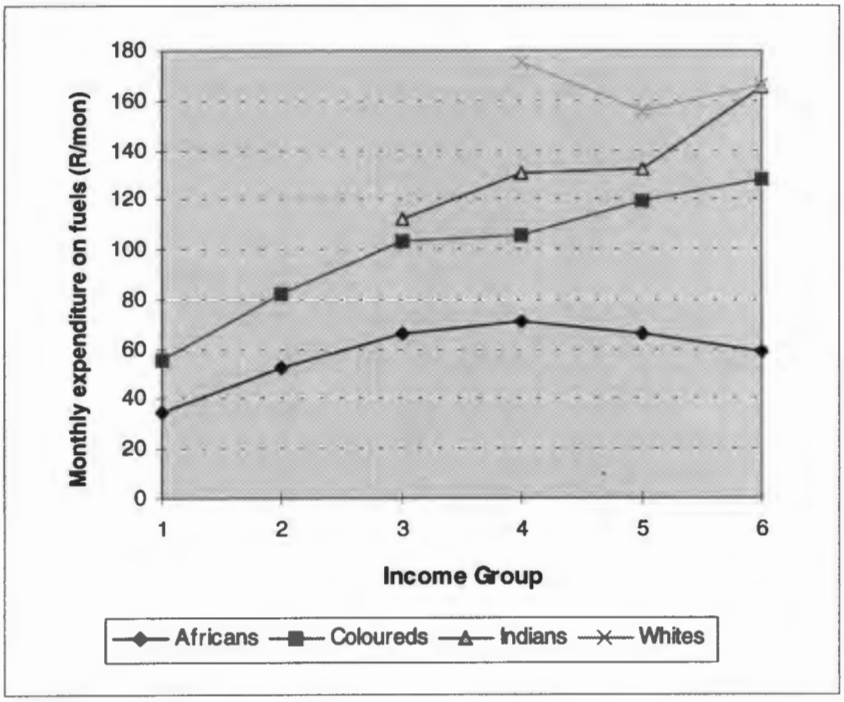


Figure 6.20: Average monthly fuel expenditure by households in different income groups of different racial groups in South Africa

For the White households no clear relationship is seen between the two variables (household income and energy expenditure) and, perhaps, the appropriate relationship lies beyond the analysis here since most of the households are in the income group 6. For the Indian and Coloured households, the average total expenditure on fuels generally increases as household income improves. The households tend to spend more on energy as they become empowered with more income. In the case of the African households, they tend to spend more on energy as their income improves but only up to the fourth income group. Beyond the fourth income group, African households tend to spend a little less on energy. This might be due to the fact that, beyond income group 4, expenditure on (or rather consumption of) wood by households usually falls (Figure 6.15) and shifts to other fuels. In the case of African households, this energy consumption shift is not largely towards electricity due to the lack of access to electricity.

6.3.8 Wood collection

As mentioned in Section 6.3.6, most of the households in South Africa who use wood for fuel usually collect them from farms or natural woodlands. Therefore, the actual value of fuelwood used does not reflect in the household expenditure on energy. In Figure 6.21 it is shown that over 25% of South African households collect all or part of their wood from available sources without buying it. Wood collection is more prevalent in the former homeland areas than in the areas of the former provinces. Whilst about 50% of the households in the former homeland areas are involved in wood collection, only about 8% in the areas of the old provinces collect their wood.

Although no monetary value is usually attributed to fuelwood that is collected from the bush, the social cost involved can be enormous. Wood collection is usually a chore performed by women and children, which means that other essential activities of those women and children are severely hampered since wood collection often consumes a lot of time. According to Best (1979: 71) women in African villages spend a long time collecting wood, averaging up to 15 hours a week, a chore that hardly exists for an urban housewife. There is physical hardship of collecting and carrying the bundle of wood, which causes pain in the heads, necks and shoulders.

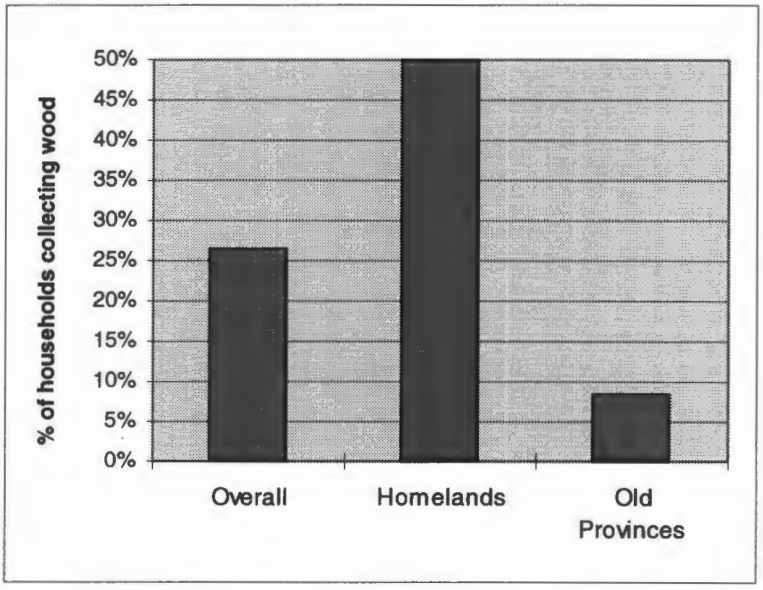


Figure 6.21: Percentage of households collecting wood in South Africa

Figure 6.22 illustrates that fuelwood collection is mainly a low-income household affair. Households tend to stop collecting wood as their income improves. For the households in the areas of the former homelands, the percentage of households collecting wood drops from over 75% at the lowest income level to about 10% in the highest income level. This shows how people's dependence on wood as a fuel could probably be reduced enormously as they are provided with income generation opportunities. In this way, environmental degradation resulting from wood denudation is also reduced.

7.
Standardisation of energy use data collection

The standardisation of energy use data collection was looked at in terms of a national objective for updating the data in the energy database in a properly structured manner. Up until now, the data in the database does not come from a common, uniform source, where data is known to be current and accurate. Dissimilar research methodologies, differing surveys during different periods of time, and the lack of national coverage in terms of data collection have hindered effective coherent study of the energy use patterns of the domestic sector. Since the data is not periodically updated within a national framework, the information available becomes less and less relevant and it does not adequately inform energy policy-making and planning.

A single, unified national approach to energy use data gathering is required to identify where the needs are and the strategic interventions that are feasible. The data must be gathered on a specified periodic basis in a basic standard form so that it can be easily used for updating the database. Although this approach has been presented to the DME several times during the period of the project, enough support was not forthcoming for it to be initiated. A standard questionnaire for the purpose of periodic national data capture is recommended in this regard. In this way, the information derived from the database can be compared over time and the resulting analysis could reflect current situation.

To achieve this periodic energy use data collection in a standardised national format, two main strategies have emerged. One option is to optimise the opportunities already available in the October Household Survey of the Central Statistical Service (currently called Statistics South Africa -SSA) to capture the basic information required on a national basis. This survey usually covers many socio-economic issues in the households that would be useful for cross-tabulating with domestic energy use variables. Contacts at the SSA have indicated that this collaboration is possible, although the coverage in terms of data fields would be very limited since efforts are made to cover issues of other government departments as well in this same survey. Appropriate data fields for this periodic SSA survey could be drawn from the standard questionnaire mentioned above and this would have to be negotiated with the SSA if the idea is found to be practically feasible.

Another strategy is to explore domestic energy use data gathering by grassroots participation. The intention here is to use the services of the development officers of the local councils for gathering energy use data in the households as part of their usual responsibilities. Since these officials are in touch with the communities, they invariably have the trust of the people and are au-fait with the socio-economic conditions of the localities. They therefore represent a valuable data-gathering resource that could be harnessed. In return, the local councils could benefit from a feedback in the form of an Energy Use Report for their particular locality, which could be a valuable document for informing and assisting the councils in their energy planning at the community level.

For the second strategy, an initial pilot phase was proposed in a progress report of this project for gathering survey data for one or two magisterial districts using the

development officers at the local councils. This pilot phase could not be carried out due to lack of funds. A basic questionnaire for this purpose would have to be drawn from the standard questionnaire and discussed with interested parties (i.e. the development officers, researchers and policy makers). Once the survey questionnaires have been returned from the various localities, the data could then be captured into a central database. Subsequently, the data is analysed to obtain information about the energy use patterns in those communities and an Energy Use Report is written in a simple language as a feedback for the participating localities. In the pilot phase, database and information management mechanisms could be established, the necessary survey data-gathering procedures could be accomplished, feedback system for the communities would have been set up, and the problems involved in implementing such a strategy would be identified. If the pilot phase proves feasible, the implementation could then be expanded to the national level.

For the long-term objective of the implementation of the grassroots data gathering, the establishment of a central Energy Information Centre is proposed at the national level. This centre would co-ordinate and administer the periodic surveys in selected localities, gathering and organising comprehensive energy use data in a central database for dissemination to policy makers both at the national and community level. The centre would capture the data into on-line databases (like the NDEUD web site) that can be queried by those with access to the Internet world-wide. Besides, the centre would provide printed reports to the participating localities, comparing their energy use patterns with national goals and objectives. In this way, those without access to the Internet would still have the necessary feedback. Policy recommendations could evolve out of such reports. The centre could become a one-stop on-line shop for domestic energy information in the country. The information provided would be more reliable and extensive since the databases would be updated periodically by the data captured at the grassroots level.

These strategies have been discussed with officials from the DME and it was suggested that the Independent Development Trust (IDT) be consulted for advice when the implementation of the grassroots data gathering strategy becomes feasible. The usefulness of this strategy in the proposed Regional Electricity Distributors (Reds) system could also be explored. It is hoped that a standardised format and procedures for energy use data collection would eventually evolve out of these strategies.

8.
Conclusions and Recommendations

This project has pulled together data on household energy use into a common database that allows a deeper understanding of the basic energy needs of people, especially low-income households. It utilises the integrated energy planning approach that allows all the energy issues of the household, as well as other sectors, to be brought into a common system for effective analysis of the problems in order to evolve appropriate solutions. Besides linking together already aggregated data that were scattered in various reports, the database system has been expanded to include individual household records that were available in electronic format. It consists of a broad range of data on energy use and energy-related information assembled in a user-friendly Microsoft Access database. This standalone system has been expanded to yield query outputs that can be viewed in a Geographic Information System (GIS) format. This system has been continuously maintained at EDRC and subsequently transferred to the DME.

It has been demonstrated in this report that the National Domestic Energy Use Database (NDEUD) system contains useful organised data that can be periodically updated in a structured manner to provide a wealth of valuable information for energy researchers, planners and policy-makers in South Africa. The outputs of the extensive data analysis carried out during this project clearly illustrate how such a resource can facilitate the identification of the basic energy needs in the various geographic locations. Some of the factors influencing these energy needs of the poor are also analysed and the outputs could provide some direction in policy-making and implementation.

For example, it is striking to notice the extent of multiple fuel use phenomenon in the whole country and the analysis points out the communities, the geographic locations and the income group brackets in which it is more of a norm than an exception. Whilst over 50% of the households in the areas of the former provinces use a single fuel for their energy needs, about 95% of the households in the former homeland areas use 2 or more fuels for their needs. Similar observations are also distinguished between rural, urban and metropolitan areas and it is made clear that the provision of a single fuel like electricity to poor households may not meet their basic needs. For the end uses that are energy intensive, poor households often prefer to use other fuels which they find affordable regardless of the cleanliness or quality of the fuel.

Another example is that the analysis helps to quantify who constitute the poor in South Africa and what the types and levels of fuels used in those households are. In the delivery of energy services to low-income households, this information could help in drawing up policies for subsidy provision and the setting up of selection criteria, especially in the case of electrification. The data analysis also gives a lot of insight into issues of low-income households like electrification and its affordability, total fuel expenditure by households, wood collection, energy end-uses, household income, household size variation and demographics. It also lays out factors that affect energy use in the low-income households and this can help bring the status of the low-income households into the national development picture in terms of energy

provision. Lessons and recommendations ensuing from the extensive analysis have been detailed in the report.

Nevertheless, there is a need for proper institutional framework for the dissemination of the energy database system so that the energy use information that can be derived from the system could be fedback to either the users at the grassroots level or the energy policy-makers. This could also help exposing the international community to the investment opportunities existing in the domestic energy sector. Due to lack of proper institutional framework required, the Internet has been explored as a means of disseminating the NDEUD system. The development of the web site is now complete together with all the query mechanisms linked to the database. The data analysis options in the user-interface of the database system is now made available on-line through the web site. In this way, access to the data in the system is not limited to only those users who are well equipped in terms of facilities and training but rather will be opened to all potential users who have access to the Internet. The web site for the database system is set up at the EDRC offices and its operation has been demonstrated to officials at the DME. There would be a need for further development of the online database in order to access all data in appropriate format.

For the purposes of the web site development and efficiency the database system has been converted into a Microsoft Access '97 format. Thus the system is now available for distribution in Microsoft Access 2.0 or Microsoft Access '97. Apart from querying the data at the web site, it is also possible to download the whole database system from the Internet.

For the information derived from the database to be continuously useful, the data would have to be updated in a structured periodic manner. To achieve this, there is a need for a single, unified national approach to energy use data gathering to identify where the needs are and the strategic interventions that are feasible. To accomplish this periodic energy use data collection in a standardised national framework, two main strategies have emerged. One option proposed is to optimise the opportunities already available in the Statistics South Africa (SSA) October Household Survey to capture the basic information required on a national basis. Another strategy is to explore domestic energy use data gathering by grassroots participation. While development officers at the local council could help with energy use data gathering, the local councils themselves could benefit from feedback in the form of proposed Energy Use Report for individual localities. At the national level, a central Energy Information Centre could be established to co-ordinate and administer the periodic surveys in selected localities, and consequently disseminate analysed information through a web site or an Energy Use Report.

Although the database system has been continuously enriched with data from emerging reports and studies, most of these were not of national coverage and the time span were not consistent. To be fully useful, some effort must be directed towards establishing a reliable and thorough data set: at the moment too much of the data is too disparate, which reflects the disjointed nature of most energy-use surveying in South Africa. The mechanisms to store and query this information are developed and in place but what is left is a structured and consistent way of gathering and organising the necessary information.

The system could also be extended to include on-line graphics and Geographic Information System (GIS) capabilities: this functionality can be transported from the standalone database, with some further development. This would make the NDEUD

Online site a single point for the retrieval of information about household energy use in South Africa, and for the generation of presentation graphics and charts for inclusion into research reports.

9.
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Appendix A: List of objects forming the database

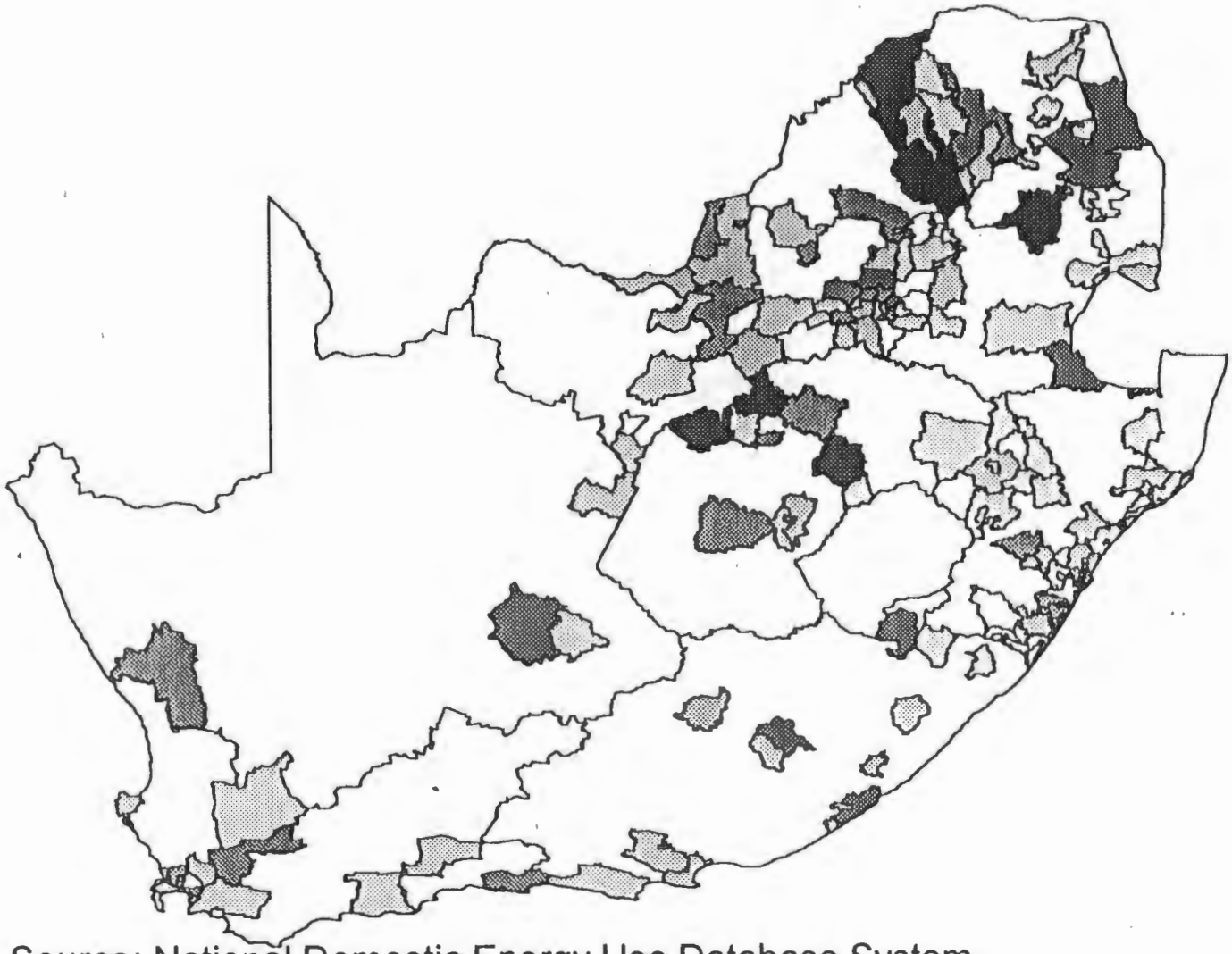
Item	Type	Location	Description
Add data category to survey	Form	NDEUD	Allows the addition of data categories to a document
appliances	Table	ENGDATA	Table contains appliance data for surveys
Aspect covered by surveys	Table	ENGDATA	Aspect data for each survey
Aspect covered in survey subform	Form	NDEUD	Displays the aspects covered by a document's surveys - subform in Edit_Document
AutoExec	Macro	NDEUD	Macro that hides the database and activates the NDEUD - executed when NDEUD database is
CPI	Module	NDEUD	CPI Conversion functions
CPIIndex	Table	NDEUD	CPI Index values for various years
Customize	Form	NDEUD	Form allowing cusomization of the data in Customize Table
Customize	Table	NDEUD	This table contains customizable information for the NDEUD database
Customize_Embed	Form	NDEUD	Form listing all customizable options embedded into form CUSTOMIZE
Data held in survey subform	Form	NDEUD	Displays the info covered by a document's surveys - subform in Edit_Document
DataWiz_ClearIncludeFields	Query	NDEUD	Clears all included fields in the Data Wizard
DataWiz_ClearRestrictions	Query	NDEUD	Clears all restrictions in the Data Wizard
DataWiz_EmbedRestriction	Form	NDEUD	Allows the entry of restrictions in the DataWizard - subform in DataWizard
DataWiz_Fields	Table	NDEUD	DataWizard table of available fields
DataWiz_IncludeFields	Form	NDEUD	Lists included fields in the DataWizard - subform in DataWizard
DataWiz_IncludeFields	Table	NDEUD	DataWizard table of fields included in a DataWizard session.
DataWiz_ResLookup	Table	NDEUD	DataWizard table of resolution fields available at a particular resolution
DataWiz_Restrictions	Table	NDEUD	DataWizard table of restrictions available for the DataWizard
DataWizard	Form	NDEUD	DataWizard main form
DB_Structure	Table	NDEUD	This table - info on every database object, also used for table reattachment
DB_Update	Table	NDEUD	Table of updates made to the database- just for administration
Debug	Module	NDEUD	Debugging functions
doc and summary	Query	NDEUD	Basic query for entering document data - summarizes surveys for the document
document	Table	ENGDATA	List of the documents in the database
document_status	Table	ENGDATA	Lookup table of possible status codes for documents.
Edit_Document	Form	NDEUD	Main form for editing documents
Edit_Documents_Select_Survey	Form	NDEUD	List of a document's surveys - subform in Edit_Document
Edit_Keywords	Form	NDEUD	Form to allow editing of available keywords
Edit_Localities	Form	NDEUD	Used to edit available localities
Edit_Survey	Form	NDEUD	Main form for the editing of surveys
elec_attitude	Table	ENGDATA	Survey data for attitudes to electricity
employment	Table	ENGDATA	Employment data for surveys
fuel	Table	ENGDATA	Fuel data for surveys
GIS	Module	NDEUD	GIS related functions
GIS_MakeNewPat	Query	NDEUD	Creates new GIS Point Attribute Table (PAT) file for export

Item	Type	Location	Description
GIS_MakeNewPat_exSaldru	Query	NDEUD	Creates new GIS PATfile for export from the Saldru Wizard
GIS_Temp	Query	NDEUD	Temporary file created as an intermediary for GIS export
Globals	Module	NDEUD	Globals available to all modules
hh_expend	Table	ENGDATA	HH Expenditure data for surveys
hh_income	Table	ENGDATA	HH Income data for surveys
Homelands	Table	NDEUD	List of possible homelands
housing	Table	ENGDATA	Housing data for surveys
Info covered in surveys	Table	ENGDATA	Info data for each survey
InfoWizard	Form	NDEUD	Main form of the Info Wizard
InfoWizard	Module	NDEUD	InfoWizard functions
InfoWizard	Table	NDEUD	All reports and queries registered with the Info Wizard
Interpret	Module	NDEUD	Functions for interpreting restrictions
IWI_*	Report	NDEUD	Reports registered with the Info Wizard
IWI_*	Query	NDEUD	Info Wizard queries - both standalone and as the data set for reports
KeyWords	Module	NDEUD	Functions for breaking and checking keywords
KeyWords	Table	NDEUD	List of possible keywords
List of survey information categories	Table	NDEUD	All available survey information categories in ENGDATA
Localities	Table	NDEUD	REDUNDANT - held previous localities data, now replaced by LOCALITY table
LOCALITY	Module	NDEUD	Locality related functions
LOCALITY	Table	NDEUD	Main locality data: all possible localities.
LocalityBuilder	Form	NDEUD	Locality Builder form
Magisterial Districts	Table	NDEUD	List of Mag Districts in LOCALITY, stored here for use by some sophisticated fns requiring speed.
Misc	Module	NDEUD	Miscellaneous functions
Normal	Form	NDEUD	Used to provide default form controls in form design
PAT	Table	NDEUD	Output file for the GIS - exported to the GIS Point Attribute Table (PAT) file
PAT_Template	Table	NDEUD	Template for the output file for the GIS
PLACENAME	Table	NDEUD	Saldru-related place data - REDUNDANT
Prov_Pat_Template	Table	NDEUD	Template for the Provincial output file for the GIS
ReportBuilder	Module	NDEUD	Functions that generate reports for the DataWizard
ReportBuilderTemplate_Landscape	Report	NDEUD	Template report for DataWizard generation of Landscaped reports
ReportBuilderTemplate_Portrait	Report	NDEUD	Template report for DataWizard generation of Portrait reports
Saldru	Table	Saldru	Saldru data per respondent
Saldru_Cluster	Table	Saldru	Saldru data per cluster
Saldru_HH	Table	Saldru	Saldru data per household
Saldru_MagNames	Table	NDEUD	List of original Saldru magisterial district names, and closest matches from LOCALITY db
SaldruWiz	Module	NDEUD	SaldruWizard functions
SaldruWiz_ClearIncludeFields	Query	NDEUD	Clears all included fields in the Saldru Wizard
SaldruWiz_EmbedRestriction	Form	NDEUD	Restrictions in Saldru Wizard - subform in SaldruWizard
SaldruWiz_Fields	Table	NDEUD	All available Saldru Wizard fields
SaldruWiz_IncludeFields	Form	NDEUD	Included fields in Saldru Wizard - subform in SaldruWizard
SaldruWiz_IncludeFields	Table	NDEUD	All included fields in latest Saldru Wizard query

Item	Type	Location	Description
SaldruWiz_Restrictions	Table	NDEUD	All possible Saldru Wizard restrictions
SaldruWiz_Temp	Query	NDEUD	Temporary query used by the Saldru Wizard to interface with the Data Wizard
SaldruWizard	Form	NDEUD	Main Saldru Wizard form
SaldurWiz_ClearRestrictions	Query	NDEUD	Clears all restrictions in the Saldru Wizard
services	Table	ENGDATA	Services data for surveys
Set SaldruWiz_Restrictions from	Query	NDEUD	Updates SaldruWiz_Restrictions to include all non-stat'd SaldruWiz_Fields fields
socio_demog	Table	ENGDATA	Socio-demographic data for surveys
surv_summary	Table	ENGDATA	Summary data for surveys
survey	Table	ENGDATA	Data on each survey
SurveyCategory	Table	NDEUD	List of all possible survey categories
Tech	Module	NDEUD	Technical table-manipulation fns used in development
Tech_QueryDesign	Form	NDEUD	Technical form used for the modification of data specifications with survey information categories
Temp	Query	NDEUD	A query used as a temporary query for adding surveys and elsewhere. Do not delete, but if you do,
Title_Page	Form	NDEUD	Title page of the NDED database
Title_Page_Embed	Form	NDEUD	Displays NDED Updates - subform in Title_Page
WoodCollect	Table	NDEUD	Wood Collection data for surveys.

Appendix B:

Monthly household expenditure on electricity (R)
(in sampled magisterial districts in all provinces)



Source: National Domestic Energy Use Database System

Appendix C: Sample report outputs from aggregated data
% Households Using Fuels in N Cape - General

Magisterial District	Wood	Paraffin	Gas	Elec	Coal	Candle	Batteries
DE AAR	41.84	92.86	40.82	42.86	35.71	61.22	1.02
GORDONIA	0.00	40.63	75.00	0.00	0.00	40.63	0.00
KIMBERLEY	8.89	5.93	1.48	97.78	8.89	8.89	0.00
NAMAKWALAND	0.00	0.00	0.00	0.00	0.00	0.00	0.00
POSTMASBURG	0.00	15.00	0.00	0.00	0.00	100.00	0.00
WARRENTON	0.00	35.71	12.50	72.32	0.00	33.48	0.00

% Electrified Households Using Fuels in N Cape

Magisterial District	Wood	Paraffin	Gas	Elec	Coal	Candle	Batteries
DE AAR	12.50	82.50	25.00	42.50	27.50	12.50	0.00
KIMBERLEY	6.82	3.79	1.52	100.00	6.82	6.82	0.00
NAMAKWALAND	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WARRENTON	0.00	36.36	12.73	73.64	0.00	32.27	0.00

Appliance Ownership (% Households) in all Provinces

Province	Magisterial District	Elec Kettle	Elec Stove	Fridge	Gas Stove	Paraffin stove	Elec Geyser	TV
01 W-KAAP/W CAPE								
	BELLVILLE	86.90	88.50	87.54	39.30	5.75	79.55	92.01
	CALEDON	33.87	51.61	54.03	37.90	48.39	40.32	64.52
	CERES	73.91	95.65	89.86	28.99	10.14	78.26	66.67
	GOODWOOD	82.35	81.18	69.41	41.76	10.59	0.00	83.53
	KAAP/CAPE	96.15	92.31	92.31	0.00	0.00	96.15	92.31
	KNYSNA	100.00	89.47	100.00	7.89	5.26	100.00	92.11
	KUILSRIVIER/RIVER	100.00	100.00	100.00	17.60	0.00	100.00	97.60
	OUDTSHOORN	5.13	33.33	11.97	36.75	73.50	0.00	43.59
	PAARL	91.67	96.88	100.00	34.38	4.17	14.58	100.00
	PRINCE ALBERT	4.08	18.37	12.24	4.08	2.04	12.24	14.29
	RIVERSDAL/RIVERSDALE	67.74	66.13	47.58	70.16	16.94	9.68	66.94
	SOMERSET-WES/WEST	94.95	95.96	98.99	20.20	6.57	93.43	93.94
	VANRHYNSDORP	100.00	76.36	100.00	23.64	0.00	100.00	100.00
	VREDENBURG	64.89	64.36	65.96	59.04	0.00	50.53	82.45
	WORCESTER	93.55	93.55	100.00	19.35	0.00	100.00	100.00
	WYNBERG	63.82	65.18	68.13	30.44	27.93	55.13	77.82
02 O-KAAP/E CAPE								
	ADELAIDE	0.00	0.00	0.00	6.09	100.00	0.00	37.39
	BIZANA	0.00	0.00	0.00	13.77	83.28	0.00	11.80
	BUTTERWORTH	13.16	20.18	13.16	15.79	89.47	0.00	50.00
	COFIMVABA	0.00	0.00	8.70	10.87	100.00	0.00	7.97
	ELLIOTDALE	0.00	0.00	0.00	0.00	100.00	0.00	0.00

Province	Magisterial District	Elec Kettle	Elec Stove	Fridge	Gas Stove	Paraffin stove	Elec Geyser	TV
	STERKSPRUIT	0.00	3.33	11.67	25.56	100.00	0.00	20.00
	TABANKULU	0.00	0.00	4.55	1.30	85.06	0.00	0.00
	TSOLO	0.00	0.00	0.00	9.63	89.63	0.00	14.07
	TSOMO	0.00	0.00	0.00	0.00	97.69	0.00	0.00
	UITENHAGE	56.98	73.18	62.01	28.49	54.19	25.14	91.06
	UMTATA	0.00	1.61	4.82	15.26	97.19	0.00	4.02
	UMZIMKULU	0.00	0.00	4.69	2.17	97.11	0.00	10.47
	WILLOWVALE	0.00	0.00	15.38	28.85	90.38	0.00	25.96
03 N-KAAP/N CAPE								
	BRITSTOWN	27.78	22.22	30.56	2.78	52.78	22.22	33.33
	DE AAR	31.63	25.51	31.63	52.04	67.35	0.00	67.35
	GORDONIA	0.00	0.00	78.13	100.00	0.00	34.38	34.38
	KIMBERLEY	70.37	94.07	78.52	10.37	16.30	45.93	83.70
	NAMAKWALAND	37.50	0.00	0.00	25.00	0.00	25.00	12.50
	POSTMASBURG	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	WARRENTON	49.55	66.52	61.16	20.98	43.75	3.57	56.70
04 OVS/OFS								
	BETHULIE	0.00	0.00	14.37	17.96	100.00	0.00	13.77
	BLOEMFONTEIN	44.30	46.33	57.47	16.96	74.43	17.47	70.38
	BOTHAVILLE	3.70	3.70	17.28	4.94	51.85	3.70	27.16
	BOTSHABELO	0.00	1.84	10.60	11.06	99.08	0.00	26.27
	EXCELSIOR	16.76	20.00	10.81	2.70	59.46	6.49	25.41
	FICKSBURG	8.84	10.20	19.05	13.61	90.14	2.72	18.37
	HARRISMITH	11.83	11.83	7.53	5.38	59.14	11.83	34.41
	HOOPSTAD	9.68	38.71	9.68	3.23	45.16	9.68	30.65

Province	Magisterial District	Elec Kettle	Elec Stove	Fridge	Gas Stove	Paraffin stove	Elec Geyser	TV
	KROONSTAD	69.27	68.78	79.02	27.32	41.46	62.93	73.17
	ODENDAALSRUS	0.00	0.00	15.38	15.38	100.00	0.00	61.54
	SASOLBURG	0.00	0.00	11.76	11.76	61.76	0.00	67.65
	SENEKAL	14.10	14.10	14.10	6.41	56.41	14.10	28.21
	THABA`NCHU	10.38	10.38	9.84	6.56	93.44	0.00	54.10
	WELKOM	59.71	66.30	59.34	7.33	32.60	62.64	57.51
	WESSELSBRON	0.00	0.00	4.26	0.71	100.00	0.00	26.60
	WITSIESHOEK	3.67	0.00	1.83	3.21	88.53	0.00	26.15
05 KWAZULU/NATAL								
	ALFRED	9.71	11.65	19.74	36.25	60.84	0.00	31.07
	CAMPERDOWN	16.99	41.92	47.67	10.41	83.56	2.47	46.03
	CHATSWORTH	40.95	100.00	100.00	9.52	25.71	80.00	100.00
	DUNDEE	6.40	11.63	9.88	12.79	50.58	0.00	22.67
	DURBAN	94.69	94.69	98.23	43.36	11.50	97.79	98.23
	ESTCOURT	4.64	9.65	7.05	7.98	81.26	0.00	11.87
	INANDA	62.04	86.03	77.48	21.79	35.97	53.60	83.00
	KLIPRIVIER	34.42	43.12	42.57	11.78	65.58	19.02	52.36
	LIONS RIVER	90.63	89.06	100.00	10.94	4.69	92.19	100.00
	LOWER TUGELA	7.02	23.68	6.14	4.39	63.16	1.75	14.04
	LOWER UMFOLOZI	13.56	13.31	36.12	32.57	76.30	10.52	40.81
	MAHLABATINI	0.00	0.00	12.43	14.59	91.89	0.00	25.95
	MAPUMULU	0.00	6.25	13.84	13.39	88.84	0.00	16.52
	MSINGA	0.00	0.00	11.88	13.79	79.31	0.00	4.98
	MTUNZINI	9.73	9.73	21.68	17.26	80.53	2.65	28.32
	NDWEDWE	7.30	16.31	23.61	28.76	71.67	0.00	41.20
	NEW HANOVER	0.00	0.00	6.35	6.35	20.63	0.00	4.76

Province	Magisterial District	Elec Kettle	Elec Stove	Fridge	Gas Stove	Paraffin stove	Elec Geyser	TV
	ENGCOBO	0.00	0.00	0.00	0.00	97.22	0.00	0.00
	FLAGSTAFF	0.00	0.00	6.36	15.55	75.27	0.00	6.71
	HEWU	0.00	0.00	8.89	3.33	72.22	0.00	17.78
	HOFMEYR	0.00	3.61	0.00	0.00	60.24	0.00	0.00
	HUMANSDORP	6.33	6.33	12.66	67.09	53.16	6.33	73.42
	IDUTYWA	0.00	0.00	0.00	5.15	80.15	0.00	0.00
	KEISKAMMAHOEK	0.00	0.00	0.00	5.17	98.28	0.00	15.52
	KENTANI	0.00	0.00	0.00	7.50	98.33	0.00	15.00
	KIRKWOOD	0.00	0.00	0.00	0.00	100.00	0.00	32.14
	LADY FRERE	0.00	0.00	19.82	18.02	79.28	0.00	0.00
	LIBODE	0.00	3.11	5.59	34.16	83.23	0.00	11.18
	LUSIKISIKI	0.00	0.00	0.00	12.12	70.71	0.00	4.55
	MACLEAR	0.00	10.53	0.00	7.02	82.46	0.00	10.53
	MALUTI	0.00	5.56	1.98	7.14	89.68	0.00	10.71
	MDANTSANE	29.69	31.47	41.52	27.68	81.03	7.37	53.79
	MPOFU	0.00	0.00	7.07	5.05	85.86	0.00	5.05
	MQANDULI	0.00	0.00	0.00	5.07	85.51	0.00	0.00
	MT FLETCHER	0.00	0.00	8.12	2.99	93.59	0.00	2.99
	MT FRERE	0.00	0.00	0.00	19.57	69.57	0.00	6.52
	NGQELENI	0.00	0.00	11.76	37.82	87.39	0.00	31.93
	NQAMAKWE	0.00	0.00	4.58	7.84	100.00	0.00	38.56
	OOS-LONDEN/EAST LONDON	66.86	60.47	56.98	34.88	34.30	61.63	67.44
	PEDDIE	0.00	1.64	4.10	29.51	86.07	0.00	50.82
	PORT ELIZABETH	35.15	42.74	47.03	17.33	55.45	25.58	68.48
	PORT ST JOHNS	0.00	0.00	0.00	0.00	62.50	0.00	23.61
	QUEENSTOWN	97.33	93.33	100.00	38.67	5.33	100.00	100.00
	QUMBU	0.00	0.00	0.00	0.00	94.27	0.00	3.18

Province	Magisterial District	Elec Kettle	Elec Stove	Fridge	Gas Stove	Paraffin stove	Elec Geyser	TV
	NEWCASTLE	18.32	21.16	25.50	14.36	62.38	6.31	40.72
	NGOTSHE	0.00	0.00	0.00	0.00	5.51	0.00	0.00
	NKANDLA	0.00	0.00	32.16	12.06	51.26	0.00	29.65
	NONGOMA	8.83	0.00	10.26	12.82	73.50	0.00	8.55
	PIETERMARITZBURG	60.94	84.38	87.11	23.05	37.89	33.98	74.22
	PINETOWN	70.11	76.44	80.46	52.30	34.48	45.98	77.59
	PORT SHEPSTONE	4.77	11.41	25.20	27.06	85.68	0.00	46.42
	SIMDLANGENTSHA	0.00	5.23	6.40	16.86	76.74	0.00	6.40
	UMBUMBULU	8.76	12.75	16.33	19.52	87.25	0.00	28.69
	UMLAZI	18.88	36.05	29.18	19.31	90.99	0.00	28.76
	UMZINTO	66.67	100.00	91.67	26.04	0.00	70.83	84.38
06 N-WES/N-WEST								
	BAFOKENG	70.06	73.89	80.25	14.01	42.68	63.69	74.52
	DITSOBOTLA	22.78	22.78	26.58	3.80	87.34	0.00	41.77
	KLERKSDORP	62.26	63.81	63.42	23.74	29.57	59.14	82.49
	LEHURUTSHE	16.35	12.02	40.87	25.00	92.31	3.85	44.23
	LICHTENBURG	31.43	32.86	34.29	7.14	57.14	34.29	52.86
	MADIKWE	0.00	0.00	36.56	18.28	90.32	0.00	33.33
	MANKWE	5.95	5.95	26.19	9.52	94.05	0.00	48.81
	MARICO	81.05	74.74	78.95	27.37	14.74	80.00	90.53
	MOLOPO	14.00	24.57	20.86	13.14	83.71	0.00	36.00
	MORETELE 1	0.00	0.91	26.28	9.97	87.61	0.00	44.41
	ODI	13.32	14.35	43.48	5.86	86.09	15.23	49.34
	POTCHEFSTROOM	46.67	16.67	0.00	3.33	0.00	0.00	6.67
	RUSTENBURG	1.48	1.48	7.41	26.67	93.33	0.00	17.78
	SCHWEIZER-RENEKE	23.66	18.32	31.30	72.52	80.15	5.34	46.56

Province	Magisterial District	Elec Kettle	Elec Stove	Fridge	Gas Stove	Paraffin stove	Elec Geyser	TV
	SWARTRUGGENS	16.78	18.12	16.78	10.07	65.77	12.75	21.48
	TAUNG	0.00	0.00	9.23	3.69	96.31	0.00	18.82
	VENTERSDORP	21.54	10.77	28.46	3.85	50.00	10.77	59.23
	VRYBURG	0.00	0.00	0.00	0.00	68.97	0.00	0.00
07 PWV								
	BENONI	78.52	71.58	78.96	8.03	20.61	59.22	83.51
	BOKSBURG	80.41	94.59	87.16	2.70	19.59	79.73	89.19
	BRAKPAN	91.98	93.98	89.40	7.45	16.91	96.56	87.68
	CULLINAN	49.23	44.62	36.92	10.77	69.23	10.77	49.23
	JOHANNESBURG	69.24	83.25	77.11	9.37	21.14	28.69	76.62
	KEMPTON PARK	75.54	76.50	73.86	11.03	25.90	55.64	75.78
	KRUGERSDORP	61.92	70.82	60.14	29.89	48.75	38.79	70.82
	NIGEL	0.00	0.00	22.93	0.00	70.06	0.00	36.94
	OBERHOLZER	0.00	2.63	9.65	0.00	97.37	0.00	8.77
	PRETORIA	95.46	93.99	91.17	7.98	10.67	79.75	92.64
	RANDBURG	57.96	59.61	62.07	7.88	44.99	44.50	69.13
	RANDFONTEIN	63.24	56.62	65.44	5.88	33.82	4.41	61.76
	ROODEPOORT	87.22	96.92	89.87	5.29	15.42	54.19	81.50
	SOSHANGUVE	20.31	27.97	39.08	6.90	80.08	13.41	64.37
	SPRINGS	52.57	92.00	75.43	1.14	16.57	0.00	79.43
	VANDERBIJLPARK	80.83	89.10	90.98	12.03	18.80	38.35	93.23
	VEREENIGING	40.00	46.67	56.99	18.92	56.99	35.27	58.92
	WESTONARIA	92.13	76.40	80.90	3.37	13.48	83.15	82.02
	WONDERBOOM	96.08	99.02	99.02	9.80	51.96	99.02	90.20
08 O-TVL/E TVL								

Province	Magisterial District	Elec Kettle	Elec Stove	Fridge	Gas Stove	Paraffin stove	Elec Geyser	TV
	BALFOUR	0.00	0.00	0.00	0.00	65.45	0.00	14.55
	BARBERTON	0.00	11.54	3.85	0.00	3.85	0.00	3.85
	EERSTEHOEK	17.42	4.55	20.45	6.82	88.64	4.55	12.88
	ERMELO	18.49	19.86	31.51	6.85	22.60	4.11	40.41
	HOEVELDRIF/HIGHVELD RIDGE	0.00	0.00	24.65	7.04	80.28	2.82	30.28
	LYDENBURG	22.83	20.65	22.83	0.00	13.04	19.57	46.74
	MDUTJANA	63.48	40.27	38.23	11.60	85.67	1.37	51.54
	MKOBOLA	13.87	12.26	30.00	4.52	80.97	0.00	32.90
	MOUTSE	39.17	72.50	37.50	10.00	80.00	0.00	58.33
	NKOMAZI	4.38	10.83	19.59	1.61	56.45	0.00	21.89
	NSIKAZI	29.66	30.51	51.98	30.51	70.90	5.65	58.19
	PIET RETIEF	95.10	89.22	95.10	30.39	29.41	95.10	95.10
	STANDERTON	0.00	0.00	13.33	6.67	83.33	0.00	68.33
	WITBANK	44.56	37.48	47.50	8.98	18.13	26.42	61.66
09 N-TVL/N TVL								
	BOCHUM	28.27	24.05	31.22	12.24	72.15	0.00	31.22
	BOLOBEDU	15.40	18.97	20.68	5.29	60.19	2.18	27.06
	DZANANI	0.00	0.00	30.18	3.55	75.74	3.55	43.20
	HLANGANANI	1.09	1.09	5.82	15.09	58.18	0.00	19.27
	LULEKANI	3.37	3.37	7.87	5.62	71.35	3.37	10.67
	MALAMULELE	4.74	6.41	11.70	8.08	34.82	2.51	15.60
	MAPULANENG	5.46	5.96	12.41	6.20	72.95	0.00	18.36
	MHALA	0.00	10.81	29.73	6.08	39.86	0.00	0.00
	MOKERONG	5.47	6.67	17.78	9.91	72.14	0.68	23.42
	NAMAKGALE	26.14	67.05	57.95	4.55	70.45	14.77	42.05
	NAPHUNO	0.00	6.51	10.06	10.65	47.34	0.00	10.65

Province	Magisterial District	Elec Kettle	Elec Stove	Fridge	Gas Stove	Paraffin stove	Elec Geyser	TV
	NEBO	0.00	0.00	4.68	7.27	69.09	0.00	12.21
	PHALABORWA	29.41	31.76	29.41	2.35	9.41	21.18	30.59
	PIETERSBURG	96.94	90.82	92.86	8.16	4.08	97.96	94.90
	POTGIETERSRUS	7.14	0.00	7.14	7.14	7.14	0.00	28.57
	RITAVI	10.88	10.88	19.65	3.16	42.81	0.00	22.81
	SEKHUKHUNELAND	0.00	0.00	8.30	0.00	62.26	0.00	8.11
	SESHEGO	22.00	19.00	34.00	1.00	83.00	0.00	33.33
	THABAMOOPO	5.34	2.87	9.86	7.19	84.19	1.44	17.04
	THOHOYANDOU	36.63	33.69	41.98	18.72	37.97	18.18	55.61
	VUWANI	0.00	0.00	7.83	6.96	52.17	0.00	20.87
	WARMBAD	97.73	86.36	97.73	52.27	20.45	90.91	97.73

Appendix D: List of documents in the database system (5 pages out 46)

14-Sep-99

author	title	publisher	date	place	organization
Ackermann, R.H.	Appropriate technology for electrical reticulation	CIGRE			
Annecke W	Fuel for thought	Journal of Energy in South Africa	93/05/01	Cape Town	
Aron, J. Eberhard, A. A. Gandar, M. V.	Fuelwood deficits in rural South Africa		91/01/01		
Aron, J., Eberhard, A. and Gandar, M.	Demand and supply of firewood in the homelands of South Africa.	University of Cape Town. Energy Research	89/07/01	Cape Town	
Auditore, F.A.	Economical feasibility for the application of bare-overhead-conductor versus aerial-bundled-conductor distribution for varying population in developing areas	CIGRE			
Auerbach, R. Gandar, M.V.	Energy and small scale agriculture				
Back, D. University of Cape Town. Energy Research Institute	Review of available micro-computer design packages for passive solar design of low cost dwellings. Chapter 2. Low income housing and energy consumption	University of Cape Town. Energy Research	89/01/01	Rondebosch	
Barnard, H.B.	Customer opinions on aspects of electricity supply; a research report presented to School of Business Leadership, University of South Africa	Unisa	91/01/14	Pretoria	

author	title	publisher	date	place	organization
Barnard, HB	Electrification of workers houses		91/10/01		Eskom
Barnard, HB	Electrification Project evaluation (policies and models)				
Basson, J.A.	Energy implications of accelerated urbanization		87/05/01		
BEC	Project energy, BEC, Research proposal	Research Surveys	89/03/08		
Bembridge, T. J. Tarlton, J.E.	Ciskei woodlot survey and woodfuel strategy	Foundatn for Research & Dev. CSIR	88/04/01		Foundation for Research and Dev, CSIR
Bembridge, T.J. Coleman,M. Lategan, F.S.	Rural household energy in developing areas with special reference to te use of dung.	DMEA	92/11/01	Pretoria	Fort Hare University, Dept of Agric Ext
BENBO	Black development in South Africa	BENBO	76/01/01	Pretoria	
Bennett, K.F. University of Cape Town. Energy Utilization Unit	Energy requirements of the domestic sector	University of Cape town. Energy Utilizat	77/01/01	Rondebosch	
Bennewith D	Fredville Area		89/10/01		
Bennewith D	Hlabisa		89/11/01		Eskom
Bennewith, D	Agricultural Survey (Eastern Natal Region)				
Bennewith, D	Kyamayakazi area (Eshowe district)				
Berrisford, A.J. & Surtees, R.M.	Electrical demand characteristics of low income and developing urban communities	Eskom	92/09/01		

author	title	publisher	date	place	organization
Best, M.G.	Consumption of energy for domestic use in three African villages	Saldru	79/01/01	UCT	
Beute, N	Domestic utilisation of electrical grid energy in South Africa		93/11/01		
Blomkamp, Y.	South African renewable energy bibliography : 1975 - 1991	DMEA	92/11/01		Engineering Research
BMR	Income and expenditure patterns of non-white urban households, Johannesburg survey (multiple Asian households) 1970	UNISA. Bureau of Market Research	71/01/01	Pretoria	
Booyens Konsultante	Urban Housing (No of dwellings, elect, water supply... 1990)		90/01/01		
Booyzen, A.G.	Note on the electrification of housing premises				
Borchers M L; Archer F M; Ravenscroft P	Household energy use in Namaqualand urban areas	EDRC	91/04/01	Cape Town	
Borchers, M.L.; Archer, F.M.; Eberhard, A.A.	Namaqualand household energy survey; A study of energy consumption patterns and supply alternatives in six reserves.	Energy Research Institute	90/10/01	Cape Town	Univ Cape Town. Energy Research Institut
Borchers, ML. Eberhard, AA	Household energy supply and price trends	EDRC	91/05/01	Cape Town	NEC
Bos, H.A.	Appropriate use of prepayment meters	CIGRE			
Botha, E.C.	To develop an affordable electricity tariff model for a developing city like Soweto	Eskom. North Eastern Transvaal Region	89/01/01		

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Bureau of Market Research	Eskom-Soweto study 1989				
Buro vir Ekonomiese Politiek en Analise	Invloed van die elektrifisering van swart stedelike woonbuurtes op die Suid-Afrikaanse ekonomie	Buro vir Ekonomiese Politiek en Analise	88/10/01		
Buys, J.; Wolhuter, J.	Behoefte aan elektriese krag: Bongani Woonbuurt Douglas		90/10/01		
Campbell, A	Demographic, Perceptual and Service Centre Requirements for Duduza		92/04/24		
Campbell, K.J., Ferrando, L.J. and Krumm, D.A.	Pricing of electricity for developing communities	CIGRE			
Clark J	Lowcost small scale charcoal production in the Westem Cape		90/05/01		
Cloete, S.A. and Du Toit, J.	Structural change in the economy and energy needs: a South African perspective	Development Bank of Southern Africa	88/01/01	Halfway House	
Co-ordinated Marketing & Management (Pty) Ltd	Attitude survey on energy usage in Soweto	Econolec	90/09/01	Southdale South Africa	Eskom
CONSULTOR	Market research into the need for electricity in Driefontein		90/10/01		
Consultor	Orange Farm - Marketing for electricity supply				
Cooper, CJ	National commercial energy consumption summary excluding liquid fuels, 1991 Final Report	DMEA	93/03/01	Pretoria	

author	title	publisher	date	place	organization
Crawford, C.J.	Preliminary Market Research on Ezakheni Township	Eskom	90/02/03		Eskom
Crawford, C.J.	Preliminary Market Research On Nqutu Township		90/02/01		
Crawford, G.J.	Preliminary Market Research on Mondlo Township		90/02/01		
Crawford, GJ	Preliminary Market Research om Madadeni	Eskom	90/02/12		Eskom
CSIR?	Energy problems of developing areas	CSIR. South African Energy Information S	87/01/01	Pretoria	
CSS	Agricultural Survey Report No. 11-01-01 (1988)				
Data Research Africa cc. (Marketing and Socio-economic data Consultants)	Edendale-Imbali complex electrification survey	Data Research Africa cc.	89/11/01		
Davies, Bristow & Associates	Towns of South Africa: Black towns of the PWV, 1988	Davies, Bristow & Associates	88/10/01	Durban	
Davies, E.G.	Aspects of electricity supply to developing areas	CIGRE			
DBSA (Centre for Information Analysis). Dept. Information Generation	Development Information: Region D (vol 2) (Copy)	DBSA			
DBSA (Centre for Information Analysis). Dept. Information Generation	Development information: Region F (vol 2) (Copy)	DBSA			
De Coning, C. University of South Africa. Bureau of Market Research	Income and expenditure patterns of urban Bantu households (Benoni survey)	UNISA. Bureau of Market Research	62/01/01	Pretoria	