ENERGY UTILIZATION IN THE DOMESTIC SECTOR

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I, Andrew John Stone, submit this thesis for the degree of Master in Industrial Administration. I claim that this is my original work and that it has not been submitted in this or in a similar form for a degree at any University.

ABSTRACT

In South Africa the domestic sector is an important energy user. Information is available on how much energy is supplied to this sector but little is known about how this energy is utilized. The purpose of this thesis is to try and gather information on this area of domestic energy utilization.

As the domestic sector is made up of a large number of small users a selected sample of the users is needed to provide information which is representative of the sector as a whole. A postal survey was used to gather information from a representative sector of the White community. This method was unsuitable for the Black sector but information on Black household energy usage was obtained from a Department of Health report.

With the use of a postal survey of a sample group to estimate results for the sector as a whole, inaccurate results will occur unless the sample is truly representative of the sector. To ensure this, independent figures for the income per household and the number of urban and rural households were obtained and the sample results weighted accordingly.

The survey showed that differences exist between the way in which energy is utilized by flat and house dwellers and by urban and rural dwellers. More energy is also utilized by more affluent households. Transport was shown to be the biggest single user of energy for all White households. Electricity and coal are the most important suppliers to White households of non-transport energy.

Energy usage in households in different cities was investigated. Differences in the quantity of energy utilized were identified. The results for the electricity usage of households in Pretoria and Cape Town were compared with other independent results for these cities. Comparisons were also drawn between electrical energy usage patterns revealed by the survey and those of some overseas countries. Generally good agreement between the results was obtained.

In depth analysis of rural domestic energy utilization was not possible owing to lack of data. Energy utilization patterns for the rural domestic sector as a whole were however established.

Based on the results of the survey as well as population predictions, estimates of future energy patterns are made.

Because of the health hazard posed by the severe air pollution which occurs in Black urban areas the Department of Health has investigated the electrification of the Black urban areas. The results of this investigation provided information on the current energy usage patterns of Black households.

The main source of energy for urban Blacks is coal. Differences in the amount of coal used per household for different parts of the country were identified. In the future electricity is expected to replace coal as the major supplier of energy. Predictions based on the number of households of future electrical energy requirements are made.

Results for the Coloured and Asian domestic sector were estimated from those obtained for the White and Black sectors.

All the results from the different sections of the domestic sector were gathered together and compared with the existing available information on energy supplied to the sector.

This thesis tries to gather together information as well as provide a more complete picture of how energy is utilized in the domestic sector.

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CHAPTER ONE

INTRODUCTION

1.1 GENERAL

Since the mid-seventies people have become more aware of the term "energy" and how the supply and price of fuels affects their lives. In South Africa, individuals, both at home and in industry, have begun to question where the energy they use goes to and how their energy requirements for the future will be met. In order to answer some of these questions studies of the existing energy utilization patterns are needed whilst bearing in mind the possible influences of changes that are taking place in the world at present.

An important user of energy in developed countries is the domestic or household user. In South Africa the domestic sector utilized some 13% of the net energy (this term is defined in section 1.2) which was utilized in 1974.(1)

South African energy users can be conveniently divided into the industrial, agricultural, domestic, mining and transport sectors. The domestic sector, unlike the other sectors, is made up of many small users of energy whose individual energy usage patterns are different, and individual usage small, but who combine to use a significant portion of the energy used in this country.

Energy related statistics for South Africa are relatively scarce, particularly with regard to domestic energy usage. It was therefore decided to undertake a study of what information is available and to analyse this information for purposes of estimating and predicting energy usage patterns for the domestic sector, both now and in the future.

1.2 DEFINITIONS

Before discussing the energy utilization patterns it is necessary to define the different energy related terms which will be used. The terminology which will be used in this thesis is that which Bennett[2] used.

1.2.1 Gross Energy

This is the total amount of energy (including that used to produce the energy in the correct form) needed for an activity.

For example, if gross electrical energy for an activity is referred to, the energy required to mine the coal to produce the electricity, the losses in generation and transmission as well as the energy needed to manufacture and install all generating plant and equipment would all have to be included.

Gross energy may however only refer to fuel needed to produce the energy, secondary energy inputs being ignored. It is therefore important to define the system boundary and to establish what inputs are under consideration, otherwise misunderstandings will arise.

1.2.2 Net Energy

Net energy is the portion of the gross energy that is available to do useful work. This therefore excludes firstly, the energy needed to produce the energy in the right form and secondly, the secondary inputs associated with generation, transmission and distribution of the energy.

1.2.3 Input Energy

This is the energy which crosses the boundary (that goes "in") of a particular system. This is the energy received by the user.

1.2.4 Useful Energy

Useful energy is the energy that the consumer utilizes after its final conversion. This is the energy that the consumer "gets out" of his input energy. It takes the form of heat, light, mechanical or chemical energy and excludes all losses associated with converting the input energy into the useful energy.

1.2.5 Conversion Efficiency

This is the efficiency with which input energy is converted to useful energy.

1.3 LITERATURE SURVEY

The literature survey consisted of gathering all available information and data on domestic energy utilization. It became apparent that the available information falls into different groups. The first group was information on energy use in the country and the domestic sector as a whole. The second was information on the White portion of the domestic sector and the third was on the Black sector.

These groups will now be dealt with separately.

1.3.1 Energy Utilization in South Africa

The energy that is utilized in the Republic of South Africa may be thought of as being used in five main sectors; the industrial, agricultural, domestic, transport and mining sectors. The input energy used in these sectors[3] is presented in Table 1.

SECTOR	INPUT ENERGY MJ × 10^9	PERCENTAGE OF TOTAL
Industrial	578,6	46,7
Agricultural	40,4	3,3
Domestic	157,6	12,7
Transport	365,6	29,5
Mining	97,7	7,9
	Total 1 239,9	

TABLE 1 : Input Energy in South Africa (1974).

Table 1 shows that the domestic sector consumes a significant proportion of the country's energy.

The domestic (or household) sector consists of a large number of small energy users. As this sector covers both rural and urban as well as Black, White and Coloured areas, large differences in usage patterns within this sector can be expected.

The domestic energy figure in Table 1 does not include the energy used for domestic (private) transport.

To enable analysis of energy usage patterns, data on the types of energy (coal or electricity, etc.) is required. The Department of Planning and the Environment provides combined figures for the domestic and agricultural sectors.[4] These figures are presented in Table 2.

TYPE OF ENERGY		AMOUNT	AMOUNT IN MJ MJ × 10^9	PERCENTAGE OF TOTAL
Electricity	(10^6 kW.h)	13 341	48,0	24,2
Coal	(10^3 t)	3 640	88,5	44,7
Petroleum	(Mℓ)			
	Domestic	563	20,6	10,4
	Agricultural	1 102	40,3	20,4
Coal - gas	(10^6 m^3)	18	0,3	0,2
Gas - coke	(10^3 t)	12	0,3	0,2
			Total 198,0	

TABLE 2 : Input Energy for the Domestic and Agricultural Sectors (1974).

According to the Department of Planning and the Environment[4] the "direct consumption of electricity and coal for agricultural purposes is rather small and difficult to estimate", hence they do not publish separate energy figures for the domestic and agricultural sectors. This department has however just released a report on "Principles of Energy Conservation"[5] which gives figures for the domestic sector excluding the agricultural sector. Additional figures were also obtained from this department and are presented in Table 3.

YEAR	INPUT ENERGY - MJ × 10^9					
	ELECTRICITY			COAL		
	HOUSEHOLD	AGRICULTURAL	TOTAL	HOUSEHOLD	AGRICULTURAL	TOTAL
1974			48,0			88,5
1975	48,0	4,4	52,4	92,2	0,9	93,1
1976	52,0	4,9	56,9	98,9	1,1	99,0

TABLE 3 : Energy Consumption in the Domestic Sector for 1974 to 1976.

The figures in Table 3 for electricity do not agree with those published by the Department of Statistics. The Department of Statistics[6] indicate that in 1976 domestic input energy was some 37,7 × 10^9 MJ (10 474 × 10^6 kW.h). This is somewhat lower than the 52,0 × 10^9 MJ quoted by the Department of Planning and the Environment.

The difference possibly arises because of a different definition for the domestic sector. The Department of Planning include in the domestic sector energy used for public and street lighting, public amenities, schools, hostels and hotels. The Department of Statistics figures for the domestic sector are for purely household use.

From Table 3 it is also possible to calculate the conversion efficiencies for the various fuels. The Department of Planning and the Environment[7] released figures for conversion efficiencies based on results obtained from a postal survey. The efficiencies obtained from both sources are presented in Table 4.

CONVERSION EFFICIENCIES (%) FOR THE DOMESTIC SECTOR					
SOURCE	ELECTRICITY	COAL	PETROLEUM	COAL GAS	GAS COKE
Department of Planning	80,0	20,0	65,0	65,0	30,0
Bennett - Urban	67,0	10,0	61,0	71,0	-
- Rural	61,0	10,0	22,0	70,0	-

TABLE 4 : Conversion Efficiencies for the Domestic Sector.

The poor agreement between the figures in Table 4 and the aforementioned discrepancies in the electricity figures serve to illustrate the difficulties which exist in obtaining energy data for the domestic sector.

1.3.2 Energy Utilization in the White Portion of the Domestic Sector

The White portion of the domestic sector has been investigated by Bennett[8] and the results published in a Department of Planning and the Environment report.[9] To overcome the difficulty of establishing data for a sector which is composed of many diverse users, the method of despatching a postal survey to a selected sample was used.

Owing to practical difficulties (such as unrest in the Black areas) the survey results apply to only the White portion of the domestic sector.

Bennett's findings can be summarized as follows:-

(i) There are large differences between the energy usage patterns of urban and rural dwellers.

(ii) 99,5% of the urban respondents utilized electricity, while only 72,9% of the rural respondents utilized this energy source.

(iii) While electricity accounts for about 67% of the total energy requirements (excluding transport) of the urban population, it accounts for about only 7% of the input requirements of the rural sector. Diesel accounts for 44% of the rural requirement.

(iv) The increase in the demand for electricity is expected to be larger in the rural areas of the country.

(v) The total electricity requirements appear to be dependent on income, i.e., the larger the family income, the greater the demand for electricity.

(vi) Between 75% and 84% of the electricity requirements are converted to heat while about 5% is converted into mechanical energy and between 10% and 11% is converted into light (including television sets).

(vii) The overall conversion efficiency of electricity in the domestic sector is between 61% and 67%.

(viii) The specific requirements for coal and anthracite are expected to decrease in future.

(ix) All the coal and anthracite is converted to heat at an overall conversion efficiency of 10%.

(x) While oil accounts for about 1% of the urban energy requirements (excluding transport) it accounts for 44% of the energy inputs to rural households.

(xi) Due to the large percentage of oil (99%) used for static machinery drives in rural areas, the over efficiency of conversion of this energy source is low (22%). In urban areas this fuel is converted at an efficiency of 61%.

(xii) Gas and paraffin supply relatively small percentages of the total energy requirements of both urban and rural householders.

(xiii) Transport energy requirements exceed other domestic energy requirements.

(xiv) Approximately 80% to 90% of the respondents utilize petrol as a transport fuel.

(xv) The overall efficiency of conversion of energy in the domestic sector is 30% in urban areas and 21% in rural areas. The reason for these seemingly low values is the high percentage of energy converted in internal combustion engines.

1.3.3 Energy Utilization in the Black Portion of the Domestic Sector.

This portion of the domestic sector has been the subject of an investigation which was conducted by a team of consultants and advisers for the Department of Health.[10]

The Department of Health undertook this study because air pollution, caused by the usage of solid fuels in Black urban areas is posing a problem, being both a health hazard and an unsightly nuisance.

Results on Black energy usage habits were obtained from a series of interviews which were conducted with a selected sample of the population. These results, together with other statistics, are used to estimate current and future energy needs of this sector.

The government has decided to go ahead with the electrification of Black urban areas and this will make substantial changes to the existing energy usage patterns of this sector.

Each sector will now be discussed in more detail.

CHAPTER TWO

THE WHITE DOMESTIC SECTOR

2.1 GENERAL

The postal survey was despatched by Bennett on 1 July 1976 to 2 180 people distributed over South Africa. A copy of the questionnaire appears in Appendix G.

In any sampling technique where one wishes to establish population parameters from sample statistics, the larger the sample the more accurately one can predict the population parameters. However, the larger the sample the more data one has to analyse and the more expensive the operation becomes, hence there is an optimum sample size.

Bennett wished to estimate South Africa's energy usage to within an accuracy of ± 1%.(11) When Bennett related this to the domestic sector he found that an accuracy of 4,2% was needed.(11) By employing the technique of using a normal distribution with 95% confidence limits it was established that a sample size of 545 was required.(12) This figure together with an assumed 25% response to the questionnaire led to the sample size of 2 180.

The questionnaires were distributed around the country in the same way as the White population is distributed. To ensure a random distribution of the questionnaires in each particular area a sample was drawn at random from the Electoral Roll. The survey was then despatched to these people.

At that stage it was thought that the survey could also establish the energy requirements of the Black and Coloured sectors of the community. The questionnaire states that energy details of all people on the property, including servants and farm workers, be included. The remaining rural Black population are likely to consume relatively insignificant amounts of energy.

The urban Blacks, Asians and Coloureds were originally included in the survey. Addresses were obtained from government departments and questionnaires despatched. A poor response was obtained (disturbances broke out in Black areas about that time), hence a representative sample was not obtained.

The initial response to the questionnaire was poorer than expected, so a further 5 000 questionnaires were despatched.

Owing to the large amount of data gathered (about 200 000 pieces of information), Bennett used a computer program to manipulate the data. This program is very comprehensive and allows the user to select a number of options. Further options have been added and it is therefore possible to choose data as follows:

(i) Urban or rural dwellers.

(ii) English or Afrikaans.

(iii) House or flat.

(iv) Race - White, Black, Coloured or Asian.

(v) Province.

(vi) Income
- Less than R 2 000 per annum
- R 2 000 to R11 000 per annum
- R11 000 to R20 000 per annum
- Above R20 000.

(vii) City or area based on postal code.

(viii) Summer or winter electricity input energy.

In any sampling technique care has to be taken to ensure that an unbiased sample has been obtained. Here the sample was distributed over the entire country to Whites selected at random. To check that the results are representative of the White community as a whole, Bennett(12) performed a check on the income of the sample dwellers. The results were grouped according to different incomes and the resulting distribution of income compared with that obtained by the Department of Statistics. The income groups and the distribution obtained is presented in Table 5.

INCOME (RANDS/ANNUM)	INCOME DISTRIBUTION (% OF ECONOMICALLY ACTIVE WHITE ADULTS)	
	POSTAL SURVEY	DEPARTMENT OF STATISTICS
Less than 2 000	3,3	21,4
2 000 - 11 000	63,4	65,8
11 000 - 20 000	26,1	10,3
Above 20 000	6,1	2,2
Income not stated	1,1	0,2

TABLE 5 : Distribution of Income in the White sector.

Therefore in order to obtain representative results for the sector it is necessary to determine results for the individual income groups and then to combine the results using a weighted average technique.

A further check was done on the distribution of urban and rural dwellers. The ratio of urban White dwellers to rural White dwellers[13] is 86,7 to 13,3. Again urban and rural data can be isolated and then combined using a weighted average.

In order to convert the raw data obtained from the questionnaires into energy data, a number of constant values and conversion factors had to be used. The conversion factors and constant values which Bennett used have been used here.[14] Bennett states that these factors may have an error of ± 10% associated with them, but better values are not readily available.

The Department of Planning and the Environment presents tabulated results for electricity, coal, oil, gas and paraffin usage in the domestic sector.[15] However the results presented for a particular energy source represent averages for users of that energy source only. It is therefore not possible to directly combine the data to obtain overall energy consumption figures. The survey data has therefore been analysed again to obtain average values for each energy source for users irrespective of whether they use that energy source or not. This will yield averages which may be combined directly to yield overall figures for energy usage of all types for all users.

2.2 RESULTS FOR THE ENTIRE WHITE SECTOR

In order to obtain these results, results for urban and rural as well as all the different income groups (both urban and rural) have to be obtained and then combined.

It was decided to concentrate on obtaining figures for input energy. It seems likely that conversion efficiencies are not likely to vary greatly around the country, hence if input energy figures are available, useful energy figures can readily be estimated if they are required.

Results for the different income groups for both urban and rural sectors are presented in Appendix A. The mean values as well as the sample standard deviations are given.

These means and sample standard deviations of the different income groups may be combined to obtain an estimate of the urban and rural mean and the standard deviation of this mean. This enables confidence limits to be placed on the predicted mean. The method for doing this appears in Appendix B.

In order to combine the results for urban and rural households to obtain a result for domestic households as a group, the ratio of urban to rural households must be known.

The ratio of urban dwellers to rural dwellers is 86,7 to 13,3. However the postal survey showed that the number of people per household is different in the urban and rural sectors. To allow for this the number of people per household for each income group was obtained and the results combined using a weighted average to obtain an average figure for the number of people per household for the urban and rural sectors. These results are presented in Appendix C.

The results for the average White household (excluding servants) shows that there are 3,3 people per household in the urban and 12,9 people per household in the rural sectors.

This combined with the ratio of 86,7 to 13,3 for urban to rural dwellers leads to a new ratio of 96,2 to 3,78 for urban households to rural households. This implies that the average White South African household has 3,66 dwellers.

This ratio was used to obtain the results for an average White domestic household. These results are presented in Appendix A3.

All figures are presented as a mean value with an upper and lower limit. These are 95% confidence limits based on estimates of the standard deviation of the population mean calculated from the sample data standard deviations.

From Appendix A3 it can be seen that there is a big difference between urban and rural energy usage patterns. It can also be seen that the results for the rural sector are inaccurate, particularly the figures for oil. This is unfortunate as it leads to large errors in the estimation of quantities for the sector as a whole. The reason for this error is that the sample size for the rural sector was too small.

It is still possible to see usage patterns for the two sectors. Firstly, in both sectors transport energy requirements are larger than all other requirements combined. In the urban areas the mean input energy used for transport lies between 53% to 63% of the total input energy while in the rural areas the figure is higher, being between 57% and 82%.

If the energy requirements excluding transport requirements are looked at, the importance of electricity in the urban sector (mean usage of 64% to 72% of input energy) contrasts with the low usage of electricity in the rural sector (between 5,8% and 7,7%). Coal accounts for roughly the same percentage of input energy in both sectors, but the actual amount is very different as the total amount of energy used in the rural household is so much greater than in the urban household (mean total input energy lies between 37 798 MJ to 46 062 MJ compared with 64 336 MJ to 385 804 MJ).

If the energy requirements for transport are looked at, petrol is seen to account for nearly all of the urban requirements whilst in the rural sector diesel assumes a greater importance. The rural figures for transport include the fuel used for farming equipment, hence the high usage of diesel.

In order to calculate the total energy requirements of the White domestic sector, the number of households in this sector must be known. It has already been established that there are 3,3 people and 12,9 people per household in the urban and rural sectors respectively. Together with the ratio of urban to rural households of 96,2 to 3,78 this yields an average figure of 3,7 people per household.

According to the Department of Statistics,[16] the White population in 1975 was 4 237 000. This means that there were about 1 145 000 households in the White sector. This compares favourably with the official figure of 973 235 for 1970.[17]

The mean values for the average household in Appendix A3 have been taken and used to produce an estimate of the energy used by the White portion of the domestic sector. These results are presented in Table 6.

TYPE OF ENERGY	INPUT FOR WHITE SECTOR GJ × 10^6	TOTAL FOR DOMESTIC SECTOR GJ × 10^6	PERCENT USED BY WHITE SECTOR
Electricity	32,2	48,0	67
Coal	15,1	88,5	17
Oil	5,5	20,6	27
Gas	1,4	-	
Paraffin	1,8	-	
Total	55,9	157,6	35
Transport Energy			
Petrol	66,4	171,7*	38,7
Diesel	17,6***	64,5**	27,3
Paraffin	1,9		
Total for Transport	85,9		
Total for all Energy inputs	141,8		

* This is the total Petrol Input Energy to the Transport sector for Automotive usage.

** Total input energy for all diesel used in the Transport sector.

*** Includes some diesel used for farming.

TABLE 6 : Input Energy for the White Domestic Sector.

From Table 6 it can be seen that the Whites consume some 67% of the electricity used in the domestic sector although they account for only about 17% of the population. For coal the picture is different with the White sector using 17% of the input coal energy. These figures reflect the fact that most Black areas do not have electricity and depend on coal and other fuel sources for energy.

Of the energy used for transport in South Africa, the White sector is seen to consume a significant percentage, namely, 32%.

The rural and urban sectors will now be considered in more detail.

2.3 THE WHITE RURAL DOMESTIC SECTOR

The sample size obtained for the rural sector was small. This precludes further subdivision of the sample into geographic areas. It is therefore not possible to investigate if the energy usage patterns in this sector are different for different areas of the country.

The survey does however still provide enough information to enable the following conclusion to be drawn:-

(i) Electricity was utilized by 72,9% of the rural households.(18)

(ii) In rural areas electricity was mainly utilized for lighting, water heating and refrigeration. The proportion for lighting being much higher for the rural household than for the average household.

(iii) Electricity accounts for 5,8% to 7,7% of the input energy. This is undoubtedly due to lack of electrification in rural areas, but with the rising cost of oil (used to generate power on the farm) there will probably be an increased demand by farmers to be connected to the national power grid.

(iv) About 43% of the rural dwellers used coal.[19] The coal is used chiefly for open fires, water heating and cooking.

(v) A reduction (6% per year) in the demand for coal is expected,[19] people preferring to use more convenient sources of energy.

(vi) The oil used on farms is mainly for static machinery drives, 99% of the oil being converted into mechanical energy.[20] It appears however that oil usage varies greatly amongst rural dwellers as this was the data which showed an extremely high variance.

(vii) Gas is utilized mainly for cooking, water heating and room heating. Gas is utilized by 51% of the rural dwellers,[21] but accounts for only 2,4% to 4,3% of the input energy requirements. This is possibly because gas is used as a supplementary source of energy when electric power is not being used (or supplied by the farm generator).

(viii) Paraffin supplies between 5,3% and 12,2% of the input energy, 73% being converted to heat, 26% to mechanical energy and 1% to light.[21] Paraffin refrigerators appear popular as 25% of the respondents used paraffin for this purpose.

(ix) Diesel supplies most of the energy used for transport, followed by petrol and paraffin. No attempt was made to isolate farming usage from household usage.

2.4 THE WHITE URBAN DOMESTIC SECTOR

In the urban sector differences exist in energy consumption between people living in flats and those living in houses.[29]

The distribution of income per household for flat and house dwellers is not available. Therefore to eliminate differences that may occur owing to differences in income, it was decided to choose the median income group (namely, R2 000 to R11 000 per year) for purposes of comparison. The results for this group are presented in Appendix A4.

These results show that a family in a house uses more energy than a family in a flat, the total input energy (including transport) being 116 647 MJ (± 7%) and 61 805 MJ (± 11%) for houses and flats respectively. Bennett[22] concluded that this was generally the case for families in flats and houses. The chief reason for this would appear to be the difference in size of family between those living in flats and those living in houses. In the sample taken there were an average of 4,3 people per family (servants included) for houses and 2,2 people per family for flats. If the energy used is then recalculated on a per capita basis no significant difference exists between the input energy used by house dwellers and that used by flat dwellers in the sample.

In both house and flat dwellers the energy used for transport exceeds the energy used for all other purposes, accounting for some 60% of the total input energy. This is in agreement with Bennett[23] who concluded that "the car uses more energy than the total requirements of the home with which it is associated". Petrol supplies most of the energy needed for transport, supplying 95% (± 7%) for house dwellers and nearly 100% for flat dwellers. Diesel supplies the balance for flat dwellers and nearly all of the rest for house dwellers, in addition to which some house dwellers use small quantities of paraffin (for tractors on small holdings).

The largest source of energy (transport excluded) for both house and flat dwellers is electricity, followed by coal.

Electricity supplies house dwellers with 68% (± 3%) of their input energy and flat dwellers with 92% (± 7%) of their input energy. Coal supplies some 27% (± 8%) of input energy to house dwellers. Flat dwellers also utilize coal, 5,5% (± 4,2%) for energy.

The coal used by flat dwellers is not used by them directly but is utilized in central water heating systems. The house dwellers use most of their coal (68%) for open fires. The rest is used for water heating (about 25%) and cooking (about 8%). It is expected that the usage of coal will drop - Bennett[24] states that urban users expect a reduction of coal usage of 2% within one year of the survey.

Oil supplies house dwellers with less than 1,5% of their input needs (excluding transport). No flat dwellers in the sample used oil (other than for transport). The house dwellers all used their oil for heating. It is likely however that with the large increase in oil prices that this source of heating will become less popular.

Gas supplies between 2,1% and 3,2% of the input energy for house dwellers and between 1,1% and 2,8% of the input energy for flat dwellers. The gas appears to be used mainly for cooking and water heating. Gas fires are also used, being more popular in houses than in flats.

Paraffin accounts for between 1,6% and 3,2% of the input energy for houses and less than 1% of the input energy for flats. The paraffin is used mainly for heating.

As electricity is the most important (non transport) source of energy for the urban sector it was decided to concentrate on this energy source and look at it in more detail.

2.4.1 Electricity Usage in the White Urban Sector

It was decided for similar reasons as before to look at the income group R2 000 - R11 000 per year.

Within this group it is expected that differences will exist in the electricity usage patterns of house and flat dwellers. In order to investigate this, the electricity input energy used by different electric appliances was established from the survey data. These results for the White urban house and flat dwellers having an annual income between R2 000 and R11 000 is presented in Appendix D.

When comparing these results it must be remembered that, as before, the number of people occupying the average house is nearly double that in the average flat (4,3 people as opposed to 2,2 people). It is therefore not surprising that electricity consumed by appliances in the house is in nearly all cases greater than in the flat. It is interesting to note that the amount of electricity used by the refrigerator is virtually the same in both cases. This is reasonable as over a limited range of family sizes the size of the refrigerator needed (hence the electricity used) is more or less constant.

If the percentage of the electricity used by each appliance is looked at, some differences are seen. The hot water geyser uses a higher percentage of the electricity used in the flat than in the house (36,8% compared with 33,0%). This is in contrast with the use of deep freezers. Fewer flats than houses appear to have freezers (18% compared with 66% of the dwellers have freezers), hence electrical use is on average lower for freezers in flats than in houses (3,6% or 784 MJ/a compared with 10,8% or 3 464 MJ/a).

The percentage electricity used for lighting is about the same in both cases being about 7% to 8%. The stove also uses about the same percentage of the electricity used (4% to 5%), but the actual amount of electricity used is higher in the house than the flat. Heating also consumes about the same percentage in flats and houses (about 11%).

The other electrical appliances are seen to consume small amounts of the electricity used (all less than 3% each), however, together they consume some 15% of the electricity used.

It is of interest to try and compare these electricity usage results with those of other overseas countries. It must be remembered that the results under discussion here came from the White urban sector of the community having a specific income. The income group is the median one so the results are reasonably representative of the White urban sector as a whole.

Figures were obtained for New Zealand and the United States of America.

In New Zealand in 1972-1973, the average electricity consumption per household in the urban areas was 7 150 kW.h/a (25 740 MJ/a).[25] This appears to be for houses. Unfortunately no indication is given of the average number of dwellers per household. This figure for total electrical input energy compares favourably with the figure for household electrical usage obtained from the survey, i.e., 32 074 MJ/a. The survey results are from 1976 whereas the New Zealand results are from 1972-73, hence the survey results may be expected to be higher as there is a general trend of increasing electricity consumption with time, both here and in New Zealand.

The New Zealand Electricity Department reached similar conclusions concerning the effects of number of occupants and increasing income on electricity demand; namely, that both these factors served to increase electricity consumption.[26] The New Zealand survey also showed that electricity consumption is higher in urban than in rural areas.

In New Zealand electricity is used as follows:-[27]

(i)	Hot water systems	43,6%
(ii)	Cooking (stove and all appliances used in food preparation)	12,8%
(iii)	Space heating, other appliances and lighting	43,6%

This pattern is different from the South African one, where the comparable figures are:-

(i)	Hot water systems	33%
(ii)	Cooking and all food preparation appliances	7%
(iii)	Heating and all other appliances	60%

There are many possible reasons for the differences, some of which are climatic differences, different housing standards, sizes and types, different family sizes and living styles.

In the United States the picture is different. Figures for electricity consumption for the average American household as well as per capita figures are available.[28] This enables the results to be calculated for an average South African sized household (4,3 people). The results are presented in Table 7.

APPLIANCE OR FUNCTION	USA HOUSEHOLD (1970)		USA (SOUTH AFRICAN SIZE HOUSEHOLD)		SOUTH AFRICAN HOUSEHOLD	
	MJ/a	%	MJ/a	%	MJ/a	%
Lights and Small Appliances	8 096	33	10 690	33	15 963	50
Stove	2 685	11	3 546	11	1 507	5
Clothes Dryer	1 386	6	1 829	6	135	0,4
Water Heater	6 951	28	9 178	28	10 584	33
Heating	1 351	5	1 784	5	3 721	12
Cooling	4 157	17	5 488	17	164	0,5
T o t a l	24 626	100	32 515	100	32 074	100

TABLE 7 : Household Energy consumption in the USA and South Africa.

These results show the tremendous popularity of air conditioning in the USA, something which is not widely used in homes in South Africa. The same thing applies to electric clothes driers. In South Africa where there is generally lots of sunshine and often a domestic servant, most families hang their washing outside to dry, hence the low usage of tumble driers.

In the USA, central heating (usually oil or gas fired) is very popular. Hence the lower usage of electricity for direct heating in the USA than in South Africa. The results for water heating are very similar. Some USA central heating systems supply hot water as well as room heating, hence it is not surprising that in the USA on average the water heater uses less energy than in South Africa.

The usage of electricity for the stove is higher in the USA than in South Africa. This could be due to different usage patterns of the stove, such as the preparation of more hot foods in a colder climate. In the postal survey used to establish the South African results, no information was gathered on the usage of the oven for baking or roasting. Hence the South African figures are lower than they should be. If it is assumed that the oven is used for 3 hours a week (to cook one roast and some baking) and that the oven element is rated at 2,5 kW (but as it is thermostatically controlled it only operates half the time), then over a year the oven could use some 750 MJ. This would raise the figure for input energy for South African stove usage by 50%, but would still leave the figure lower than in the USA.

The pattern of electricity usage will also change with the seasons. In summer the usage of electricity will drop as little electricity is being used for heating. Air conditioning is not popular in South Africa, so increased summer usage of air conditioners does not tend to raise the summer load as is the case in the USA.

As the results being used were obtained from a postal survey, separate metering of summer and winter loads was not possible. However the survey respondents were asked the number of months of the year for which they used their heaters. If the electricity used for other reasons is assumed to remain constant over the year, by adding the heating load in winter and assuming it is zero in summer, it is possible to get some idea of the winter and summer electricity patterns. This has been done and the results for houses and flats in the R2 000 - R11 000 income group appear in Appendix D3 and D4.

These results show that in winter, water heating and room heating use about the same amount of electricity, together accounting for 50% to 60% of the electricity used. In summer water heating is the most important single user of electricity, followed by refrigeration. The tendency towards bigger refrigerators and increased usage of the "frost-free" type has increased usage of electricity for this purpose. In the USA the average energy used per refrigerator per year has risen from 1 242 MJ in 1950 to 4 680 MJ in 1970.[29] It is likely that this kind of trend has been followed in South Africa.

2.5 WHITE URBAN DOMESTIC ENERGY PATTERNS AROUND THE COUNTRY

In order to try and establish if there are any major differences in urban energy patterns for cities in different parts of the country it was decided to isolate the results for certain cities. The cities chosen were Bloemfontein, Cape Town, Durban, Johannesburg and Pretoria. These cities were chosen because they fall in areas of the country having different climates and there also appear to be enough sample respondents in each city to give reasonable results.

The results for each city are presented in Appendix A5. To enable direct comparison between the cities, the same income group for each city was chosen, namely, the R2 000 - R11 000 per annum group.

If the total input energy (excluding transport) is looked at, it will be seen that the average household in Johannesburg and in Cape Town consumes more energy than elsewhere, whilst Bloemfontein is significantly lower. The high figure for Johannesburg and Cape Town may be attributed to the higher use of coal in these areas. In both cases all the coal is used for open fires.

The efficiency of conversion of coal for this purpose is low, hence the high input figures.

Virtually no coal or oil appears to be used in Durban. In the other cities coal and oil is used mainly for room heating, hence it is not surprising that no oil or coal is used in Durban because with the warm climate little room heating is needed.

Johannesburg and Pretoria both use more electricity than elsewhere. This phenomena will be looked at when the electricity usage patterns of the different cities are investigated.

Petrol is the most popular fuel for transport with isolated usage of diesel occurring. Pretoria dwellers, followed by those in Johannesburg and Durban, appear to use the most petrol. This may be due to the fact that in Johannesburg and Pretoria there are only interconnecting train services between the Reef towns with no extensive suburban networks. In addition many people in Pretoria and Johannesburg live considerable distances from their work owing to the size of these cities.

Cape Town and Bloemfontein are seen to use less energy for transport. This is possibly because Bloemfontein is a small city (hence people do not travel such large distances) and in Cape Town an extensive suburban train service coupled with a bus service exists.

Unfortunately owing to the small sample size and the resultant inaccuracies in the results obtained for each city it is difficult to draw more specific conclusions about the energy usage patterns.

Electricity is the single most important (non-transport) energy source and this is now looked at. The results are presented in Appendix D5.

The usage of electricity in all the cities appears to be very similar except for Durban. The figure for heating for Durban is much lower than for the other cities - around 2% as compared with 8% to 19% elsewhere. This low usage of heating has the effect of raising the percentage usage of the other appliances. In particular hot water heating accounts for about 46% of the input electrical energy for a household in Durban as compared with 32% to 39% elsewhere.

The usage of electricity for heating is higher in Johannesburg. This may be as a result of municipal air pollution laws which prohibits open fires in most areas, hence the use of "clean" electric heating. The climate of Johannesburg is also colder in winter than either Pretoria or Cape Town,[30] hence more energy is likely to be used for heating in Johannesburg than in the other cities.

The CSIR[31] has conducted a survey of the electricity usage patterns of certain houses in Pretoria. The electricity used for water heating was measured directly using a meter connected to the geyser circuit. This method can be expected to give a figure which is more accurate than that which can be obtained from a postal survey as no estimation of parameters (e.g., efficiency of geyser) is involved.

Results are available for 87 houses. These results indicate that water heating accounts for 43% (± 2%) of the input electricity. In terms of actual quantity of energy the figure is 13 916 MJ/a (± 278 MJ).

The postal survey indicates that in Pretoria 38,2% (± 6,7%)

of the input electricity is used for water heating, the quantity being 13 826 MJ (± 2 425 MJ). These results show that there is no significant difference between the results obtained by the postal survey and the CSIR results.

Figures are also available for how electricity is utilized in households in Cape Town.[32] These results together with the comparable postal survey results are presented in Table 8.

APPLIANCE OR FUNCTION	INPUT ENERGY (MJ/a)	
	POSTAL SURVEY	PUBLISHED RESULTS
Water heater	11 422	22 723
Stove	1 343	7 603
Refrigerator	5 391	1 728
Kettle	865	1 642
Washing machine	402	130
Toaster	83	173
Iron	327	518
Polisher	10	43
Radio	635	518
Lighting	2 395	1 771
Freezer	2 171	5 184
Other	4 094	216
T o t a l	29 138	42 249

TABLE 8 : Electricity Usage for the average White Cape Town household.

The published results show that water heating accounted for some 60% and stoves some 20% of the electricity used. Both these figures are considerably higher than those obtained in the postal survey (40% and 5% respectively). The average total consumption of electricity which the published results report is also much higher than that obtained from the postal survey.

It is possible that the postal survey results are slightly too low, as the survey made no allowances for wastage of energy, for example hot taps left dripping, lights left on, etc. However it is felt that factors such as these are unlikely to contribute more than an additional 10% or so to the energy figure.

It is possible that the published results may differ from those obtained from the postal survey because those tests were done over a number of years, mostly prior to 1976. As there has been an increasing trend of electricity consumption (from 1970 to 1974 domestic and agricultural use of electricity rose from 31×10^6 GJ to 48×10^6 GJ)[33] it is possible that as the published results are for a period prior to the postal survey those results should be lower than those of the postal survey.

2.6 FUTURE ENERGY USAGE PATTERNS IN THE WHITE DOMESTIC SECTOR

A prediction of energy requirements in the future can be made if the number of households in the future are estimated and then the amount of energy per household estimated according to present figures.

Population estimates are available[34] for the years 1975 to 2000 in 5 yearly intervals. If it is assumed that the number of people per house is going to remain at the present level of 3,7 (see Section 2.2) then the number of households can be estimated. The estimates for each different form of energy are now discussed separately.

2.6.1 Input Electrical Energy in the Future

The average input electrical energy per household in 1976 was 28 080 MJ per annum. By considering the rate of increase of income and of energy usage, Bennett(35) has established that by 2000 the average household will use the same amount of energy that the average household in the + R20 000 group used in 1976. This figure was 54 816 MJ (see Appendix A1 and A2).

Values for the per household usage for years between 1976 and 2000 can be obtained by linear interpolation. Hence knowing the number of houses the total energy usage can be predicted. The results appear in Appendix E1(a).

2.6.2 Input Coal Energy in the Future

With coal usage it is not possible to establish a strong trend with income. It does however appear that in the top income group coal usage is lower than average. It would seem likely that in the future the amount of coal used per household will drop as more convenient forms of energy become more popular. Also the tendency to employ fewer servants and the introduction of smoke-free zones will lead to a decrease in the popularity of open fires. For this reason it is thought that the 1976 average of 13 188 MJ per household for input coal energy will drop by 50% to 6 594 MJ by the year 2000. The current amount of input coal energy used by the over R20 000 a year group is 6 733 MJ. Hence if the assumption that by the year 2000 most of the households will be consuming energy at the same rate as the current + R20 000 a year group, the assumption that coal usage per household will be 6 594 MJ by 2000 seems reasonable.

Figures for years between 1976 and 2000 can again be obtained by linear interpolation. The results appear in Appendix E1(b).

2.6.3 Input Oil, Gas and Paraffin Energy in the Future

The figures obtained in the survey for oil (non transport), gas and paraffin do not show a trend with increasing income. In addition future usage of these fuels is going to be greatly influenced by the price and availability of oil. Hence any prediction of usage of these fuels in the future based on past results is likely to be highly inaccurate. Hence it was decided not to attempt to predict figures for future usage of oil, gas and paraffin. These fuels also do not constitute a significant percentage of the input energy to the domestic sector and hence are of lesser importance.

2.6.4 Input Energy for Transport Purposes

Figures are available(36) for the present and expected number of White owned motor cars in the country.

From the postal survey the input energy for petrol, diesel and paraffin for transport was obtained. The figure for petrol is probably nearly 100% private "domestic" motoring, as little petrol is used for agricultural purposes. The diesel figure is different. The diesel used in urban areas is most likely used in diesel cars, whereas the diesel used in rural areas is almost exclusively used for farming purposes.

In order to make a prediction, the number of cars used for private motoring needs to be known. The total input energy (petrol) used by cars is available.(37) Hence by knowing the total energy used by White owned cars in the domestic sector, the number of White owned vehicles in the domestic sector can be estimated by taking the same proportion of domestic cars to total cars as domestic transport energy to total energy. It is not possible to isolate figures for diesel cars. In addition usage of diesel cars is very limited hence the domestic use of diesel for transport will be neglected. As it accounts for only some 3% of the total energy used for transport in the urban sector (and probably much the same in the rural sector if farming is neglected), this does not introduce a serious error in the prediction.

These predictions are likely to be inaccurate as transport patterns are likely to change in the future as the price and availability of oil restricts its usage for motoring. However the predictions are made bearing in mind that, if it is desired to investigate other scenarios, then the figures can be modified accordingly, and it is easier to have some prediction to start with rather than none at all.

The results of these predictions and their calculations appear in Appendix E1(c).

CHAPTER THREE

THE BLACK DOMESTIC SECTOR

3.1 GENERAL

The Black population in 1977 was some 18,6 million people. Of these 5 451 000 live in urban areas.[38]

No information is available on the energy consumption of the rural Blacks. However it is likely that their energy consumption is low, comprising mainly usage of local fuels, such as wood and dung for open fires.

The urban Blacks living in and around the cities are major users of energy. At this stage coal is their prime source of energy. This will change radically in the future because the government has decided to undertake a program of electrification of Black urban areas.

The energy consumption patterns of the urban Blacks at present and what the patterns are likely to be in the future will now be discussed separately.

3.2 CURRENT ENERGY UTILIZATION PATTERNS

The Black urban population in 1977 was 5 451 000. The distribution of these Blacks around the country is shown in Table 9.[39]

AREA	NUMBER	PERCENT
Transvaal	3 300 000	60,5
Cape Province	932 000	17,1
Orange Free State	610 000	11,2
Natal	609 000	11,2
T o t a l	5 451 000	100,0

TABLE 9 : Distribution of Urban Black Population.

The people are accommodated in houses, hostels and some live in White areas (domestic servants, etc.). The distribution in 1977 was as follows:-

380 000 people in hostels,
320 000 in White areas and
4 751 000 in houses.

From this it can be seen that most of the energy usage patterns of the urban Black sector will be determined by what the energy usage patterns of the Black households are.

There are on average 9,1 people to every house.[40] This leads to a total number of Black houses of 522 000.

3.2.1 Electricity Usage

Most Black houses throughout the country do not have electricity. However there are some houses which do have sufficient electricity and some which have restricted amounts available. In these houses the current which can be drawn is limited by circuit breakers. The distribution of houses having electricity is shown in Table 10.[41]

	NUMBER OF HOUSES	PERCENT
Sufficient electricity	77 100	14,8
Restricted electricity	38 900	7,5
No electricity	406 000	77,7
T o t a l	522 000	100

TABLE 10 : Number of Black houses with electricity (1977).

Of the 77 100 houses with sufficient electricity 17 000 are in Soweto. These houses in 1976 consumed 76 million kW.h.[42] This is equivalent to 16 094 MJ per house. It is estimated that Black households account for some 400 million kW.h per year[43] or some 12 528 MJ per house per year for those with electricity.

Information is not available on how this energy is used. Information is available on appliance ownership.[44] These results are presented in Table 11. The results reflect percentage ownership of appliances for households which have electricity.

APPLIANCE	PERCENTAGE OWNERSHIP	
	SOWETO	ELSEWHERE
Iron	90	93
Kettle	81	87
Record Player	71	87
Stove	80	33
Refrigerator	80	33
Polisher	5	20
Washing Machine	10	20
Water Heater	10	13
Sewing Machine	10	7
Hot Plate	48	7

TABLE 11 : Black Appliance Ownership.

The results in Table 11 were gathered from a survey conducted for the Department of Health for the investigation of the electrification of Black areas. It is interesting to note the low usage of hot water heaters. This contrasts strongly with White electricity usage patterns where in urban areas ownership of a geyser varies from 79% (for lowest income group) to 100% for the highest income group.[45] A possible reason for this low geyser usage in Black households is the high cost of purchase and installation of a geyser. A further difference is the lack of usage of electricity in Black households for heating.

3.2.2 Coal Usage

The vast majority of Blacks depend on coal as their domestic energy source. In 1977 the Blacks in urban areas used about 1,7 million tons of coal of which more than 85% was used in the Highveld areas.[46]

This coal is used mainly in stoves which are used for cooking, water heating and also room heating. Owing to the ash and sulphur content of the coal, as well as often poor combustion of the coal, air pollution in Black areas and adjoining White areas has become a problem. This prompted the study, under the auspices of the Department of Health, of the electrification of Black areas.

Results from this study show that there are large differences in the usage of coal in Black urban areas depending on the climate of the area.[46] It is possible to divide the country into areas having different climates. These areas are the Coastal area (Cape Town, Durban, East London); the Highveld (Klerksdorp, Bloemfontein, Kimberley, Bethal, Vereeniging, Johannesburg); and the Middleveld (Pretoria and Pietersburg).

In the Coastal region the winter temperatures are not as low as in the Highveld. Thus much less room heating is required in these areas. This is shown in the figures for coal usage - on the Rand the average Black household uses some 4 000 kg of coal a year, while at the coast the figure is very much lower, some 100 kg to 300 kg per family being used.

The fact that the difference in coal usage between the Highveld and the Coastal region is mainly due to heating, is shown by the peak usage of coal in winter on the Highveld. The winter peak in coal usage on the Highveld is some 76% higher than the summer average usage, whereas at the coast the winter consumption is only 16% to 20% higher than the summer average.

On the Highveld only 20% of the houses have ceilings.[47] This poor insulation, coupled with the fact that a coal stove cannot be "turned on or off" at will, (hence is left to burn all night), further adds to the winter fuel usage.

Final figures for coal usage, as established by the Department of Health,[48] are presented in Table 12. The figures for tonnage of coal have been converted into energy figures (MJ) by using the figure of 26 MJ/kg coal.[49]

U S A G E	TONS PER YEAR	MJ PER YEAR
Normal household usage	1 370 000	$35,6 \times 10^9$
Heating	370 000	$9,6 \times 10^9$
T o t a l	1 740 000	$45,2 \times 10^9$
Average Highveld and Middleveld house	3,600	93 600
Average Coastal house	0,175	4 550
Countrywide average	2,813	73 138

TABLE 12 : Black coal usage in households in different areas of South Africa.

In addition to coal, many Black households use wood as a source of energy, particularly at the coast. This may also explain the lower usage of coal in the Coastal region than in the Highveld.

3.2.3 Black Domestic Transport Energy

Direct figures for the usage of energy by Blacks for transport do not appear to be available.

What is available are figures for the Black ownership of motor vehicles. These figures were released by the Driessen Committee of Inquiry into Urban Transport Facilities in the Republic[50] and are presented in Table 13.

POPULATION GROUP		URBAN	RURAL	TOTAL
White	1970	1 245 000	161 000	1 406 000
	1980	1 999 000	182 000	2 181 000
	1976*	1 697 000	174 000	1 871 000
Black	1970	42 000	21 000	63 000
	1980	201 000	33 000	234 000
	1976*	137 000	28 000	165 000

*Based on linear interpolation of the 1970 and 1980 data.

TABLE 13 : Vehicle ownership - Number of Passenger cars.

Energy usage figures for transport for White urban and rural households were established in Section 2.2 and predictions for the future made in Section 2.6. Here the input energy per annum for cars for domestic usage was established as being equal to 78 000 MJ per annum per car.

If it is assumed that the energy usage for domestic purposes is the same per car in the Black sector as in the White sector, an estimate of Black domestic transport energy can be made.

A further assumption is needed with regard to the percentage of Black owned motor cars which are used for domestic as opposed to business purposes. This figure is not available, but it is likely that the percentage of business cars is lower in the Black sector than in the

White sector (in 1976 45,4% of White owned cars are "domestic" cars). It was decided to assume that in 1976 10% of Black owned cars were used for business purposes and that this percentage would rise to the same level by the year 2000 as that of White owned business vehicles.

These assumptions led to the results presented in Table 14.

YEAR	NUMBER OF BLACK OWNED CARS	PERCENTAGED USED FOR DOMESTIC PURPOSES	NUMBER USED FOR DOMESTIC PURPOSES	TOTAL INPUT ENERGY MJ × 10^9
1976	165 600	90	149 000	11,6
1980	234 000	82,5	193 000	15,1
1985	556 500	73,1	407 000	31,7
1990	879 000	63,8	561 000	43,8
1995	1 201 500	54,4	654 000	51,0
2000	1 524 000	45,4	686 000	53,5

TABLE 14 : Transport Energy Usage in the Black Domestic Sector.

3.2.4 Total Energy Usage

Gas and paraffin are also used by Black households. The Department of Health[51] showed that 68% of households in Soweto (76% of those elsewhere) have a gas or primus stove. In addition 24% of the households in Soweto (18% elsewhere) owned paraffin driven refrigerators.

No information is available on the usage of these appliances or on how much gas and paraffin is used.

Total energy figures for coal and electricity for urban

Blacks have been established. Energy figures for rural Blacks are not available but are likely to be low. The total energy figures that have been calculated are presented in Table 15.

SOURCE OF ENERGY	INPUT FOR BLACK SECTOR MJ × 10^9	TOTAL FOR DOMESTIC SECTOR MJ × 10^9	PERCENT USED BY BLACK SECTOR
Electricity*	1,44	48,0	3,0
Coal*	45,2	88,5	51,1
Oil	?	20,6	
Oil for Transport	11,6	236,5**	4,9

* For urban Blacks only.

** Total for all automotive transport.

TABLE 15 : Input Energy for the Black Domestic Sector.

3.3 FUTURE ENERGY USAGE PATTERNS IN THE BLACK DOMESTIC SECTOR

The energy usage pattern of the Black sector is going to change radically because of the government decision to electrify Black urban areas. The demand for electricity will therefore increase rapidly while the demand for coal should drop. In addition energy figures will generally increase as the number of Black increases. In addition the improvement in the standard of living of Blacks will mean greater energy usage.

In order to predict the future energy demands it is necessary to know how the population and number of houses is going to increase. The number of Black dwellers per house is on average 9,1. This together with future urban population statistics leads to the following estimate of Black houses:-[52]

1977 - 522 000 houses
1980 - 572 000 houses
1985 - 660 000 houses
1990 - 762 000 houses
1995 - 879 000 houses.

These estimates are likely to be conservative owing to current housing shortages, hence the figure of 9,1 people per house will probably be lower in the future, thus meaning more houses.

In order to estimate how much electrical energy Black households are likely to use, a comparison is drawn between Black households and sub-economic White households. The average sub-economic White household uses 500 kW.h per month,[53] or some 21 600 MJ per year of electrical energy. The figure compares well with the figure obtained from the postal survey of 18 439 MJ ± 30% for the White urban dwellers having an income of less than R2 000 per annum (see Section 8.2). The comparison of Black households to sub-economic White households is reasonable as it is estimated that by about 1983 the income of the two groups will be the same.[53] Using this electrical energy figure (21 600 MJ per household) and the number of houses leads to a prediction for future electrical energy demand in the Black sector (see Table 16).

Prediction of the amount of coal that will be used is more difficult. The usage of coal will drop as electricity takes over. However some coal is still going to be used for heating and cooking purposes. It is likely that coal stoves will still be retained by many Black houses as there will be no market for used coal stoves once electricity is available. It is likely therefore that even though electricity will be extensively used for cooking, coal stoves may still be used as a supplementary source of heating in winter.

If the coal usage figures for White urban households are looked at (see Appendix A1) it can be seen that the households with an income less than R2 000 per annum used 17 618 MJ of coal energy per year. For higher income groups the figure is seen to be about 10 000 MJ per year. The figure for the lower income group is inaccurate, owing to the small sample size, and the mean may range from about 8 600 MJ to 26 500 MJ. The current Black usage per household of coal is 86 590 MJ. If an assumption is made that coal usage will drop to about 15 000 MJ per household with the advent of electrification (by 1985) it is possible to estimate coal input energy figures for the Black sector (see Table 16).

A large number of factors are likely to influence the energy figures already estimated for transport in the future. The increased price of oil is likely to lead to lower vehicle usage and greater usage of public transport.

The estimates for transport together with the other energy estimates are presented in Table 16.

ENERGY TYPE	1977 MJ × 10^9	1980 MJ × 10^9	1985 MJ × 10^9	1990 MJ × 10^9	1995 MJ × 10^9
Electricity	1,44	2,88	14,4	19,8	26,6
Coal	45,2	29,1*	9,9	11,4	13,2
Oil for Transport	6,37	8,2	19,4	30,7	41,9

* Figure obtained by assuming 50% of houses used current amount of coal and the balance using new level of 15 000 MJ.

TABLE 16 : Future Input Energy in the Black Sector.

CHAPTER FOUR

THE COLOURED AND ASIAN DOMESTIC SECTOR

4.1 ESTIMATED RESULTS

This sector was not covered by the postal survey or by the Department of Health report. No direct figures for this sector are therefore available, estimates have to be made based on the results obtained in the White and Black sectors.

According to government statistics[54] there were some 381 000 Coloured and Asian households in the country in 1970. During 1970 the Coloured and Asian population was 2 639 000.[55] This means that there were an average of 6,9 people per dwelling. If it is assumed that the number of people per dwelling is going to remain the same year by year it then becomes possible, by using population estimates, to estimate the number of Coloured and Asian dwellings in the future. The average number of Whites per dwelling was established as being 3,7 by this survey while the number of Blacks per dwelling was established by the Department of Health as being on average 9,1.

If it is assumed that energy usage patterns in a household are tied to the number of people in the household, then it may be assumed that the energy usage patterns of a Coloured household will be in between that of a White and a Black household.

It was therefore decided to estimate input energy figures for the Coloured sector for 1976 by using the average of figures for the White and Black sectors. In addition it was decided to assume that by the year 2000 Coloured households will have identical energy usage patterns to White households.

This method can be used for predicting input energies for coal and electricity. For transport purposes similar assumptions were made to those used for predicting Black transport figures. However it was assumed that in 1976 Coloured and Asian usage of cars for domestic purposes was midway between the 45% of the White sector and the estimated 90% of the Black sector, namely, 68%. This together with figures for Coloured and Asian owned vehicles[56] enables an estimate to be made of the input energy for domestic transport requirements.

These results together with future projections for the Asian and Coloured sector appear in Appendix F.

CHAPTER FIVE

DISCUSSION

5.1 THE CURRENT ENERGY PICTURE FOR THE ENTIRE DOMESTIC SECTOR

The results obtained for the White, Black, Coloured and Asian sectors have been gathered together to obtain an overall picture for the domestic sector. The results are presented in Table 17.

ENERGY SOURCE	WHITE SECTOR MJ × 10^9	BLACK SECTOR MJ × 10^9	COLOURED AND ASIAN SECTOR MJ × 10^9	TOTAL MJ × 10^9
Electricity	32,8	1,44*	9,2	43,4
Coal	15,4	45,2*	19,6	80,2
Oil	5,5			
Gas	1,4			
Paraffin	1,8			
Transport				
Petrol	66,4**	11,6	8,6	86,6
Diesel	17,6**			
Paraffin	1,9**			

* For urban areas only.

** Includes some usage for agricultural purposes.

TABLE 17 : Input Energy for the Entire Domestic Sector for 1976.

The results show that from the previous totals presented in earlier returns for the White, Black, Coloured and Asian sectors, a total for the domestic sector of

$43,4 \times 10^9$ MJ of input electrical energy and a total of $80,2 \times 10^9$ MJ of input coal energy is estimated.

The actual figure for electrical energy supplied to the domestic sector was $10,474 \times 10^9$ kW.h for 1976.[57] This is approximately $37,7 \times 10^9$ MJ which is 13% lower than the figure calculated from the survey results. It is possible that the assumptions made concerning the Coloured and Asian sector were poor and hence the figure of $9,2 \times 10^9$ MJ predicted for this sector is too high.

If the Black and White sector results are added a total of $34,24 \times 10^9$ MJ is obtained. If this is subtracted from the known total of $37,7 \times 10^9$ MJ a figure of $3,5 \times 10^9$ MJ is obtained. It is possible that this is a more reasonable figure for the Coloured and Asian input electrical energy.

It is also possible that differences in what constitutes the domestic sector are responsible for the discrepancies in the figures (see Section 1.3.1).

The Department of Planning and the Environment state that household usage of coal in 1976 was some $98,9 \times 10^9$ MJ (see Table 3).

According to the Department of Health[58] current production of coal is some 70 million tons, of which 3,8 million tons was supplied to coal merchants who in turn supply domestic and some commercial users (smaller factories, schools, hostels, etc.) with their coal.

The Transvaal Coal Owners Association[59] states that the average energy content of coal supplied to the domestic sector is 26 MJ/kg. The 3,8 million tons is therefore equivalent to $98,8 \times 10^9$ MJ. This figure (which includes some commercial and public users) is the same as that which the Department of Planning and the Environment release for the household users.

It therefore appears likely that the Department of Planning and the Environment's definition of "domestic" and "household" include such things as schools, hotels and certain public undertakings.

The figure of 80,2 × 10^9 MJ estimated in this report for purely household usage seems therefore to be reasonable.

It was not possible to estimate figures for oil, gas and paraffin usage in the Black and Coloured sectors.

This means that it is therefore not possible to obtain total input energy figures for the domestic sector.

The total amount of petrol energy consumed in 1974 by motor vehicles was 171,7 × 10^9 MJ.[(60)] This is used mainly by motor cars. The equivalent figure for 1976 is not available as the information is calssified, but owing to fuel saving measures it is thought likely that the 1976 figures will be similar to the 1974 ones, little growth having taken place in oil usage. Petrol input energy in the domestic sector amounts to some 86,6 × 10^9 MJ or about 53% of the total amount of petrol energy used in the country. Based on this and a figure of 410,8 × 10^9 MJ for total oil input energy in the country,[(60)] the amount of energy used for private motoring (i.e., "domestic" motoring) accounts for some 21% of the country's oil usage.

These figures for 1976 have been used to make predictions for the future energy usage in the domestic sector.

5.2 FUTURE ENERGY USAGE FOR THE DOMESTIC SECTOR

Predictions for the energy usage patterns for the White, Black, Coloured and Asian sectors have been made and the combined results are presented in Appendix E2.

The total figures for input electrical and coal energy clearly show the effects of the decision to electrify Black areas in the future. From 1980 to 1985 the domestic usage of electricity is seen to increase by over 50% (from $57,1 \times 10^9$ MJ to $86,5 \times 10^9$ MJ) whilst coal usage drops by about 33% (from $62,9 \times 10^9$ MJ to $41,6 \times 10^9$ MJ) during the same period of time.

The results show that by the year 2000 the domestic sector is likely to use some $178,0 \times 10^9$ MJ (49×10^9 kW.h) of electrical energy per year. This is lower than the results predicted by Bennett (74×10^9 kW.h) and the Department of Planning (55×10^9 kW.h).[61]

The prediction made by Bennett for the White sector was an electrical energy usage of 35×10^9 kW.h (126×10^9 MJ) by 2000. The prediction made in this thesis is lower at $98,4 \times 10^9$ MJ. This difference results from firstly, a difference in the predicted White population by 2000, and secondly, in the estimation of the number of people per household (and hence the number of households) by 2000. Bennett used a population figure of 6,9 million whilst 6,6 million was used in this report. This would account for a difference of about 4% in the results (while Bennett's results are actually 28% higher). The major difference is in the number of people per family assumed. Bennett assumed 2,93 while this report assumed 3,7 (see Section 2.2). According to the Department of Statistics[62] there were (in 1970) 201 490 occupied flats and 771 745 occupied houses in the White sector. During this time the White population was 3 773 000.[63] This means that there was an average of 3,88 people per dwelling in 1970. The

3,7 people per dwelling used in this report seems therefore reasonable.

A further difference between this report and Bennett's results for the total predicted electrical energy for the domestic sector lies in the prediction of the electrical energy usage of the Black sector by 2000. Bennett[64] predicts a usage of 34 × 10^9 kW.h of electricity by Blacks by 2000, whereas this thesis predicts 9,7 × 10^9 kW.h.

Bennett based his prediction on there being 7,4 million Black dwellings by 2000 each using 4 600 kW.h per annum. The results used in this report for 2000 were extrapolated from results obtained by the Department of Health.[65] The Department of Health predicted a much higher usage of electricity per dwelling (namely, 8 400 kW.h in 1995) but for fewer dwellings - 879 000 houses instead of the 7,4 million used by Bennett.

The difference in the number of houses is firstly because Bennett used an average of 5 people per dwelling whereas the Department of Health showed the figure to be 9,1.[66] This still does not account for the large difference between the number of houses predicted by Bennett and by the Department of Health.

The Department of Health figures cover the urban areas only. The assumption is therefore that by 1995 there will be some 879 000 houses in urban areas receiving electrical power. The rest of the Black population will be living in rural areas and probably using little electrical energy. The number of Blacks in urban areas is determined by government policy, so any change in policy on Black urbanization will have an effect on the electrical energy used by the domestic sector.

The electricity usage pattern in the future could also be affected by the usage of solar energy for water heating. In the White sector water heating was shown to be the biggest single user of electricity ranging from about 30% to 50% of the input electrical energy depending on the location of the house. Solar water heating is estimated at being able to save some 75% - 90% of the electrical energy used for this purpose.[67] Hence solar water heating could save about 25% to 45% of the electricity input to a household depending on where the house is situated.

The predicted figures for transport energy were based solely on the number of vehicles predicted by the Driessen Committee and the current energy usage per vehicle obtained from the postal survey. This is likely to change in the future as the price of oil increases and its availability decreases.

The Driessen Committee[68] has recommended many changes which, if implemented, will have far reaching effects on the domestic transport pattern. The recommendations affect the domestic sector as many are aimed at increasing the usage of public transport and decreasing the dependence of people on private motor vehicles. The expansion of and central co-ordination of urban transport, the increase in density of urban residential housing, the expansion of bus and taxi services as well as increased traffic control in urban areas are all measures which have been recommended and will affect the predictions that have been made.

Another factor which would radically alter the transport energy situation by the end of the century is the discovery of a better electrical accumulator and hence viable electric motor vehicles. This would alter the electricity demand patterns of the domestic sector as well as the entire country.

It can therefore be seen that the predictions of transport energy in the future are likely to be highly inaccurate.

CHAPTER SIX

CONCLUSIONS

The domestic sector utilizes an important proportion of the energy which is supplied and converted in South Africa. Information on this sector is limited. It is also difficult to isolate information on the domestic sector as it is generally combined with agricultural data.

A postal survey was successfully used to establish the energy utilization patterns of the White domestic sector. The results of the survey showed that differences exist between the way in which energy is used in urban and rural areas, between flats and houses and between different income groups. In estimating results for the entire domestic sector allowances had to be made for these differences to ensure that the sample data was representative of the sector. Results obtained in this way compared well with other local and overseas information.

The information for the rural sector was insufficient to enable a full analysis of this sector's energy needs. Care also has to be taken to isolate domestic use of energy on a farm from purely agricultural use, otherwise inaccurate domestic energy figures result.

Information was available on the domestic energy needs, both present and future, of the Black urban sector. These results show the radical changes that will occur with the planned electrification of Black urban areas.

The Black sector and White sector results were used to provide an estimate of Coloured and Asian energy usage patterns.

In all sectors electricity and coal are the most important suppliers of energy for domestic purposes (transport excluded). In the future electricity is going to play an increasingly important rôle in domestic energy supply.

Transport energy needs are greater than other domestic energy requirements. As the supply of oil decreases and the price increases, major changes in the transport energy pattern are likely.

This thesis has shown what information is available and what information shortages exist in the field of domestic energy in South Africa. Much work remains to be done in the area of predicting future energy demands. The effects of new technology and a more energy conscious society on predictions of future demands needs to be investigated.

It is hoped that the work that has been done will provide useful information for those who wish to study and work in this area of the South African energy pattern.

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APPENDIX A.

INPUT ENERGIES FOR WHITE HOUSEHOLDS

A1 INPUT ENERGY PER HOUSEHOLD FOR THE WHITE URBAN USER FOR DIFFERENT INCOME GROUPS

INPUT ENERGY - MJ/a FOR WHITE URBAN HOUSEHOLDS		INCOME GROUP - RANDS PER HOUSEHOLD PER ANNUM				
		UNDER 2 000	2 000 - 11 000	11 000 - 20 000	OVER 20 000	WEIGHTED AVERAGE
WEIGHTING FACTOR		0,215	0,660	0,103	0,022	
Electricity	$\bar{x}$	18 439	29 268	39 554	55 968	28 595
	s	15 467	12 760	15 438	24 670	850
	n	19	573	235	48	875
Coal	$\bar{x}$	17 618	9 501	10 125	4 323	11 193
	s	10 993	12 194	8 505	5 224	1 267
	n	6	87	56	8	157
Oil	$\bar{x}$	0	305	688	2 379	325
	s	0	347	542	1 860	71
	n	0	12	8	5	25
Gas	$\bar{x}$	621	1 043	912	1 222	943
	s	488	1 001	1 097	1 213	103
	n	2	97	34	5	138
Paraffin	$\bar{x}$	1 219	828	593	359	877
	s	1 774	1 252	1 410	468	207
	n	4	119	32	5	160
TOTAL (Input Energy Excluding Transport)	$\bar{x}$	37 897	40 945	51 872	64 251	41 930
	s	35 082	43 107	31 121	3 353	2 108
	n	19	576	236	48	879
Transport Petrol	$\bar{x}$	27 688	58 291	88 766	120 175	56 236
	s	29 910	47 563	54 674	70 003	2 705
	n	8	505	224	44	781
Diesel	$\bar{x}$	0	2 388	1 613	0	1 743
	s		3 577	95		712
	n		11	2		13
Paraffin	$\bar{x}$	0	79	0	0	52
	s		0			
	n		1			
TOTAL (for Transport)	$\bar{x}$	27 688	60 758	90 379	120 175	58 331
	s	29 910	47 697	54 674	70 003	2 700
	n	8	516	226	44	794
TOTAL (for all Energy Inputs)	$\bar{x}$	65 585	101 710	142 290	184 430	99 943
	s	73 959	84 400	73 094	90 992	4 361
	n	19	576	236	48	879

A.2 INPUT ENERGY PER HOUSEHOLD FOR THE WHITE RURAL USER FOR DIFFERENT INCOME GROUPS

INPUT ENERGY - MJ/a FOR WHITE RURAL HOUSEHOLDS						
		INCOME GROUP - RANDS PER HOUSEHOLD PER ANNUM				
		UNDER 2 000	2 000 - 11 000	11 000 - 20 000	OVER 20 000	WEIGHTED AVERAGE
WEIGHTING FACTOR		0,215	0,660	0,103	0,022	
Electricity	x̄	3 490	15 031	37 600	25 796	15 123
	s	2 456	9 053	23 505	13 903	1 087
	n	4	39	31	12	86
Coal	x̄	35 208	74 899	53 644	68 109	64 034
	s	12 534	98 744	49 684	53 703	12 761
	n	2	27	16	5	50
Oil	x̄	1 824	154 736	99 813	262 770	118 624
	s	0	469 737	221 790	315 844	75 630
	n	1	17	9	6	33
Gas	x̄	4 415	9 008	5 198	4 771	7 535
	s	1 050	8 802	399	411	1 039
	n	2	32	15	10	49
Paraffin	x̄	18 295	21 885	8 441	23 167	19 754
	s	10 983	32 404	5 608	28 560	3 973
	n	3	33	13	9	58
TOTAL (Input Energy Excluding Transport)	x̄	63 232	275 559	204 696	384 613	225 070
	s	72 201	930 290	462 640	60 914	82 007
	n	5	57	36	16	276
Transport Petrol	x̄	62 928	104 318	135 662	249 730	101 847
	s	47 682	81 578	93 636	158 220	9 156
	n	5	49	32	16	92
Diesel	x̄	21 888	426 021	625 421	625 658	363 187
	s	20 636	613 637	805 639	907 644	75 040
	n	2	31	23	13	69
Paraffin	x̄	139 354	7 424	26 220	242 250	42 737
	s	0	5 430	41 200	261 998	5 268
	n	1	6	2	2	10
TOTAL (for Transport)	x̄	224 170	537 766	787 303	1 117 638	507 805
	s	51 956	619 059	812 108	957 856	45 724
	n	10	86	57	31	184
TOTAL (for all Energy Inputs)	x̄	287 402	813 325	991 999	1 502 251	732 875
	s	286 800	1 679 000	1 430 000	1 281 200	151 513
	n	5	57	36	16	114

A.3 INPUT ENERGY PER HOUSEHOLD FOR THE ENTIRE WHITE URBAN AND RURAL SECTORS

INPUT ENERGY (MJ/a) PER WHITE HOUSEHOLD							
TYPE OF ENERGY		URBAN HOUSEHOLD		RURAL HOUSEHOLD		AVERAGE HOUSEHOLD	
		MJ	%	MJ	%	MJ	%
Electricity	Lower limit	26 929	64	12 992	5,8	26 412	54
	Mean	28 595	68	15 123	6,7	28 080	57
	Upper limit	30 261	72	17 254	7,7	29 748	61
Coal	Lower Limit	8 710	21	39 022	17	10 619	22
	Mean	11 193	27	64 034	29	13 188	27
	Upper limit	13 676	33	89 046	40	15 757	32
Oil	Lower limit	186	0,4	0		0	0
	Mean	325	0,8	118 624	53	4 797	10
	Upper limit	464	1,1	266 859		10 402	21
Gas	Lower limit	741	1,8	5 499	2,4	983	2,0
	Mean	943	2,2	7 535	3,3	1 192	2,4
	Upper limit	1 145	2,7	9 571	4,3	1 401	2,9
Paraffin	Lower limit	471	1,1	11 967	5,3	1 101	2,3
	Mean	877	2,1	19 754	8,8	1 590	3,2
	Upper limit	1 283	3,1	27 541	12,2	2 079	4,3
TOTAL	Lower limit	37 798	90	64 336	29	41 584	85
(Input Energy	Mean	41 930	100	225 070	100	48 844	100
Excluding Tpt.)	Upper limit	46 062	110	385 804	171	56 104	115
Transport Energy							
	Lower limit	50 934	88	83 901	17	52 804	70
Petrol	Mean	56 236	97	101 847	20	57 949	77
	Upper limit	61 538	107	119 793	24	63 094	84
Diesel	Lower limit	347	0,6	216 109	43	9 686	13
	Mean	1 743	3,0	363 187	72	15 405	21
	Upper limit	3 139	5,4	510 265	100	21 124	28
Paraffin	Lower limit			32 412	6,4	1 274	1,7
	Average	52	0,1	42 737	8,4	1 665	2,2
	Upper limit			53 062	10,4	2 055	2,7
TOTAL for Transport	Lower limit	52 739	91	418 186	82	68 906	92
	Average	58 031	100	507 805	100	75 021	100
	Upper limit	63 323	109	597 424	118	81 134	108
TOTAL for all	Lower limit	91 395	91	435 910	59	109 933	89
Energy Inputs	Average	99 943	100	732 875	100	123 848	100
	Upper limit	108 491	109	1 029 840	140	137 763	111

A.4 INPUT ENERGY FOR WHITE URBAN HOUSES AND FLATS IN THE R2 000 - R11 000 PER ANNUM INCOME GROUP

ENERGY SOURCE		HOUSES		FLATS	
		MJ/a	%	MJ/a	%
Electricity	Lower limit Mean Upper limit	30 887 32 074 33 261	65 68 70	20 134 21 781 23 428	85 92 99
Coal	Lower limit Mean Upper limit	9 064 12 573 16 082	19 27 34	300 1 304 2 307	1,3 5,5 9,7
Oil	Lower limit Mean Upper limit	149 419 689	0,3 0,9 1,5	0	0
Gas	Lower limit Mean Upper limit	999 1 261 1 523	2,1 2,7 3,2	266 461 656	1,1 1,9 2,8
Paraffin	Lower limit Mean Upper limit	766 1 074 1 382	1,6 2,3 3,2	124 170 215	0,5 0,7 0,9
TOTAL excluding Transport	Lower limit Mean Upper limit	42 782 47 401 52 020	90 100 110	21 483 23 716 25 949	91 100 109
Petrol	Lower limit Mean Upper limit	60 666 65 925 71 184	88 95 103	32 720 37 915 43 110	86 100 113
Diesel	Lower limit Mean Upper limit	276 3 212 6 148	0,4 5,0 8,9	174	0,5
Paraffin	Lower limit Mean Upper limit	109	0,2	0	0
TOTAL for Transport	Lower limit Mean Upper limit	64 034 69 246 74 458	92 100 108	32 915 38 089 43 263	86 100 114
TOTAL	Lower limit Mean Upper limit	107 972 116 647 125 322	93 100 107	54 708 61 805 68 902	89 100 111

A.5 INPUT ENERGY REQUIREMENTS FOR WHITE HOUSEHOLD DWELLERS (OF THE R2 000 TO R11 000 INCOME GROUP) IN DIFFERENT CITIES

ENERGY SOURCE		INPUT ENERGY - MJ/a				
		BLOEMFONTEIN	CAPE TOWN	DURBAN	JOHANNESBURG	PRETORIA
Electricity	Lower limit Mean Upper limit	21 640 25 568 29 496	26 396 29 138 31 880	29 119 33 237 37 355	36 722 41 482 46 242	31 974 36 195 40 415
Coal	Lower limit Mean Upper limit	769 1 759 2 749	3 293 27 765 52 237	0	3 796 17 313 30 830	0 5 625 11 466
Oil	Lower limit Mean Upper limit	651	0	0	1 138 1 735 2 332	285
Gas	Lower limit Mean Upper limit	122	422 846 1 269	94 281 468	418 925 1 432	183 309 435
Paraffin	Lower limit Mean Upper limit	150 323 496	0 2 805 6 184	105 240 375	755 934 1 113	130 489 848
TOTAL excluding Transport	Lower limit Mean Upper limit	23 076 28 423 33 770	28 990 60 554 92 118	29 579 33 758 37 936	44 732 62 389 80 046	34 101 42 903 51 705
Petrol	Lower limit Mean Upper limit	29 495 46 841 64 187	40 037 51 712 63 387	55 981 64 527 73 073	55 072 68 622 82 172	56 562 78 848 101 134
Diesel	Lower limit Mean Upper limit	6 514	0	0	0	794 2 491 4 188
Paraffin	Lower limit Mean Upper limit	0	0	0	0	0
TOTAL for Transport	Lower limit Mean Upper limit	36 009 53 355 70 701	40 037 51 712 63 387	55 981 64 527 73 073	55 072 68 622 82 172	60 117 81 339 102 561
TOTAL Input Energy	Lower limit Mean Upper limit	51 700 81 778 111 856	79 574 112 266 144 958	86 274 98 285 110 296	107 154 131 011 154 867	99 387 124 242 149 097

APPENDIX B.

METHOD OF COMBINING SAMPLE STRATA

The domestic sector is made up of a number of different sub-sections or strata.

The strata are as follows:-

(i) urban users
(ii) rural users
(iii) Black, White, Coloured or Asian dwellers
(iv) household income less than R2 000 per annum
(v) household income between R2 000 and R11 000 per annum
(vi) household income between R11 000 and R20 000 per annum
(vii) household income greater than R20 000 per annum.

The postal survey covered the White section of the domestic sector. From statistical data the number of households in each stratum (i.e., urban, rural and the four income groups) is known. The results from the postal survey covered all these strata, but owing to different response rates from different strata, the proportions of the different strata in the survey sample is different from the actual domestic sector.

Therefore to obtain accurate results for the sector as a whole, the strata must be combined using a weighted average technique. To allow for the weighting factors the population mean (μ) and standard deviation (σ) may be calculated as follows:-[69]

$$\mu = \sum_{i=1}^{M} A_i \bar{x}_i \qquad \text{(B.1)}$$

where A_i = fractional weighting factors
$\bar{x}_i$ = strata means
M = number of strata in the sample.

$$\sigma = \sum_{i=1}^{M} \frac{A_i^2 \cdot S_i^2}{n_i} \qquad (B.2)$$

where S_i = strata standard deviation
n_i = number of data points in each stratum.

Once this population mean and the standard deviation is known, confidence limits may be placed on the mean.

For large samples (greater than 30), the 95% confidence limits on the mean are approximately:-
lower limit = $\mu - 2 \cdot \sigma$
upper limit = $\mu + 2 \cdot \sigma$

This implies that one may be 95% sure that the actual population mean lies somewhere between the upper and lower limits.

APPENDIX C.

NUMBER OF PEOPLE PER HOUSEHOLD IN THE WHITE SECTOR

C.1 PEOPLE PER HOUSEHOLD - EXCLUDING SERVANTS

AVERAGE NUMBER OF PEOPLE PER HOUSEHOLD - EXCLUDING SERVANTS					
	INCOME GROUP - RANDS PER ANNUM				WEIGHTED AVERAGE
	UNDER 2 000	2 000 - 11 000	11 000 - 20 000	OVER 20 000	
Urban	2,4	3,4	3,9	4,2	3,3
Rural	5,6	15,0	12,0	24,6	12,9
Weighting factor	0,215	0,660	0,103	0,022	

C.2 PEOPLE PER HOUSEHOLD - INCLUDING SERVANTS

AVERAGE NUMBER OF PEOPLE PER HOUSEHOLD - INCLUDING SERVANTS					
	INCOME GROUP - RANDS PER ANNUM				WEIGHTED AVERAGE
	UNDER 2 000	2 000 - 11 000	11 000 - 20 000	OVER 20 000	
Urban	2,7	3,7	4,6	5,4	3,6
Rural	6,0	15,7	15,0	34,0	13,9
Weighting factor	0,215	0,660	0,103	0,022	

APPENDIX D.

ELECTRICITY USAGE IN WHITE HOUSEHOLDS

D.1 ELECTRICITY USAGE IN THE WHITE URBAN FLAT IN THE R2 000 - R11 000 INCOME GROUP

APPLIANCE OR FUNCTION	INPUT ELECTRICAL ENERGY USED BY APPLIANCE OR FUNCTION				PERCENTAGE OF DWELLERS UTILIZING APPLIANCE
	MEAN		LOWER LIMIT	UPPER LIMIT	
	MJ/a	%	%	%	
Air Conditioner	216	0,99	0	2,1	3,2
Dishwasher	78	0,36	0	0,7	3,2
Electric Blanket	20	0,09	0,04	0,15	7,6
Food Mixer	2	0,01	0,01	0,02	31
Freezer	784	3,6	2,3	4,9	18
Floor Polisher	7	0,03	0,01	0,05	27
Geyser	8 015	36,8	34,3	39,3	96
Griller	28	0,13	0,08	0,19	19
Hair Dryer	24	0,11	0,09	0,14	49
Heaters	2 004	9,2	7,3	11,0	68
Hi-fi/Radio	327	1,5	1,1	1,8	54
Iron	205	0,94	0,81	1,08	85
Kettle	653	3,0	2,6	3,4	93
Lighting	1 699	7,8	6,9	8,7	93
Percolator	9	0,04	0,01	0,08	4
Refrigerator	5 881	27,0	24,9	29,0	98
Stove	980	4,5	3,9	5,2	86
Television	414	1,9	1,5	2,3	40
Toaster	54	0,25	0,19	0,30	60
Tumble Drier	26	0,12	0	0,25	2,5
Vacuum Cleaner	44	0,20	0,14	0,25	55
Washing Machine	261	1,2	0,7	1,6	45

D.2 ELECTRICITY USAGE IN THE WHITE URBAN HOUSE IN THE R2 000 - R11 000 GROUP

APPLIANCE OR FUNCTION	INPUT ELECTRICAL ENERGY USED BY APPLIANCE				PERCENTAGE OF DWELLERS UTILIZING APPLIANCE
	MEAN		LOWER LIMIT	UPPER LIMIT	
	MJ/a	%	%	%	
Air Conditioner	164	9,51	0,14	0,88	5,5
Dishwasher	318	0,99	0,60	1,38	8,9
Electric Blanket	67	0,21	0,15	0,26	19
Food Mixer	6	0,02	0,02	0,03	59
Freezer	3 464	10,8	9,9	11,6	66
Floor Polisher	32	0,10	0,07	0,12	49
Geyser	10 584	33,0	31,6	34,5	94
Griller	22	0,07	0,05	0,09	22
Hair Dryer	35	0,11	0,09	0,13	64
Heaters	3 721	11,6	10,3	12,8	75
Hi-fi/Radio	529	1,65	1,43	1,86	73
Iron	443	1,38	1,26	1,51	98
Kettle	847	2,64	2,41	2,87	94
Lighting	2 611	8,14	7,44	8,84	97
Percolator	13	0,04	0,02	0,07	5,3
Refrigerator	5 677	17,7	16,9	18,5	99
Stove	1 507	4,7	4,4	5,1	89
Television	654	2,04	1,79	2,29	48
Toaster	83	0,26	0,23	0,30	72
Tumble Drier	135	0,42	0,21	0,63	8,6
Vacuum Cleaner	144	0,45	0,39	0,51	85
Washing Machine	737	2,3	1,9	2,6	89

D.3 SUMMER AND WINTER ELECTRICITY USAGE IN FLATS - R2 000 TO R11 000 INCOME GROUP

APPLIANCE OR FUNCTION	INPUT ENERGY			
	WINTER		SUMMER	
	MJ PER MONTH	%	MJ PER MONTH	%
Geyser	667	32	667	40
Heating	436	21	0	0
Freezer	65	3	65	4
Lighting	142	7	142	9
Refrigerator	489	23	489	30
Stove	82	4	82	5
Other	203	10	203	12
TOTAL	2 084	100	1 648	100

Note: Figures are estimates only as based on average monthly figures with the reallocation of heating energy to winter months only.

D.4 SUMMER AND WINTER ELECTRICITY USAGE IN HOUSES - R2 000 TO R11 000 INCOME GROUP

APPLIANCE OR FUNCTION	INPUT ENERGY			
	WINTER		SUMMER	
	MJ PER MONTH	%	MJ PER MONTH	%
Geyser	890	33	890	37
Heating	727	12	0	0
Freezer	289	11	289	12
Lighting	219	8	219	9
Refrigerator	477	18	477	20
Stove	128	5	128	5
Other	378	13	378	17
TOTAL	3 108	100	2 381	100

Note: Figures are estimates only as based on average monthly figures with the reallocation of heating energy to winter months only.

D.5 BREAKDOWN OF INPUT ELECTRICAL ENERGY FOR VARIOUS CITIES

APPLIANCE OR FUNCTION		INPUT ELECTRICAL ENERGY									
		BLOEMFONTEIN		CAPE TOWN		DURBAN		JOHANNESBURG		PRETORIA	
		%	MJ/a	%	MJ/a	%	MJ/a	%	MJ/a	%	MJ/a
Freezer	Lower limit	8,61	2 201	4,53	1 320	5,12	1 702	8,0	3 319	6,50	2 353
	Mean	13,9	3 554	7,45	2 171	8,05	2 676	10,0	4 148	9,19	3 326
	Upper limit	19,1	4 883	10,4	3 030	11,0	3 656	12,0	4 978	11,9	4 307
Heating	Lower limit	4,34	1 110	4,56	1 329	0,70	233	14,6	6 056	7,41	2 682
	Mean	8,76	2 240	7,75	2 258	1,56	518	19,3	8 006	11,9	4 307
	Upper limit	12,8	3 273	11,0	3 205	2,41	801	24,0	9 956	16,4	5 936
Lighting	Lower limit	3,15	805	6,71	1 955	6,96	2 313	6,21	2 576	4,48	1 622
	Mean	4,22	1 079	8,22	2 395	9,32	3 098	8,15	3 381	7,07	2 559
	Upper limit	5,30	1 355	9,74	2 838	11,7	3 889	10,1	4 190	9,67	3 500
Refrigerator	Lower limit	17,3	4 423	16,5	4 808	14,5	4 819	11,5	4 770	13,3	4 814
	Mean	21,5	5 497	18,5	5 391	16,9	5 617	13,2	5 476	15,8	5 719
	Upper limit	25,6	6 545	20,5	5 973	19,3	6 415	15,0	6 222	18,3	6 624
Stove	Lower limit	3,17	811	3,68	1 072	3,66	1 216	3,08	1 278	3,74	1 354
	Mean	5,35	1 368	4,61	1 343	4,83	1 605	3,81	1 580	4,80	1 737
	Upper limit	7,53	1 925	5,55	1 617	6,00	1 994	4,54	1 883	5,85	2 117
Water Heating	Lower limit	26,9	6 878	34,7	10 111	41,8	13 893	30,1	12 486	31,5	11 401
	Mean	32,7	8 361	39,2	11 422	46,0	15 289	33,2	13 772	38,2	13 826
	Upper limit	38,5	9 844	43,7	12 733	50,1	16 652	36,2	15 016	44,8	16 215
Other		13,6	3 477	14,3	4 167	13,3	4 420	12,3	5 102	13,0	4 705
TOTAL	Lower limit	84,6	21 640	90,6	26 396	87,6	29 119	88,5	36 722	88,3	31 974
	Mean	100	25 568	100	29 138	100	33 237	100	41 482	100	36 195
	Upper limit	115,4	29 496	109,4	31 880	112,4	37 355	111,5	46 242	111,7	40 415

APPENDIX E.

FUTURE INPUT ENERGIES FOR THE DOMESTIC SECTOR

E.1 PREDICTED RESULTS FOR THE WHITE DOMESTIC SECTOR

(a) Electricity

YEAR	WHITE DOMESTIC ELECTRICAL INPUT ENERGY			
	WHITE POPULATION	NUMBER OF HOUSES	INPUT ENERGY PER HOUSE MJ	TOTAL INPUT ENERGY MJ × 10^9
1976	4 326 380	1 169 000	28 080	32,8
1980	4 684 650	1 266 000	32 536	41,2
1985	5 155 690	1 393 000	38 106	53,1
1990	5 640 730	1 525 000	43 676	66,1
1995	6 134 830	1 658 000	49 246	81,6
2000	6 641 200	1 795 000	54 816	98,4

Assumptions:

(i) Number of dwellers per house remains constant at 3,7 people per house.

(ii) Energy usage per household in 2000 is the same as current energy usage in the + R20 000 per annum income group.

(b) Coal

YEAR	WHITE DOMESTIC COAL INPUT ENERGY		
	NUMBER OF HOUSES	INPUT ENERGY PER HOUSE MJ	TOTAL INPUT ENERGY MJ × 10^9
1976	1 169 000	13 188	15,4
1980	1 266 000	12 089	15,3
1985	1 393 000	10 715	14,9
1990	1 525 000	9 342	14,2
1995	1 658 000	7 968	13,2
2000	1 795 000	6 594	11,8

Assumptions:

(i) Number of dwellers per house remains constant at 3,7 people per house.

(ii) Coal usage per household by 2000 drops to half the present level.

(c) <u>Transport Energy</u>

No prediction for diesel or paraffin is being made as both are used mainly for agriculture and also figures for domestic vehicles vary, a figure for these fuels is not available.

Total petrol energy sold in South Africa	$= 171{,}7 \times 10^9$ MJ
Total used in White domestic sector	$= 66{,}4 \times 10^9$ MJ
Total number of motor cars in South Africa	= 2 199 000
∴ number of White vehicles used in domestic sector	$= \frac{66{,}4}{171{,}7} \times 2\ 199\ 000$
	= 850 000 cars.

This figure seems reasonable as the total number of White owner cars in South Africa was 1 871 000. This therefore implies that 45,4% of White cars are used for domestic purposes as opposed to trade or business purposes.

This then leads to a per car usage of energy as follows:-

Total petrol energy used in White domestic sector	$= 66{,}4 \times 10^9$ MJ
Number of cars used for domestic purposes	= 850 000
∴ Input energy per car	= 78 000 MJ

This figure together with figures for the predicted vehicle population can then be used to predict the total input energy for transport for the future. A further assumption has to be made and that is that the ratio of domestic to business usage of cars remains constant and that the per vehicle usage remains the same.

INPUT ENERGY USED FOR TRANSPORT IN THE WHITE DOMESTIC SECTOR			
YEAR	NUMBER OF WHITE OWNED CARS	NUMBER OF "DOMESTIC" CARS	TOTAL INPUT ENERGY MJ × 10^9
1976	1 871 000	850 000	66,3
1980	2 181 000	991 000	77,3
1985	2 660 000	1 208 000	94,2
1990	3 140 000	1 427 000	111,3
1995	3 619 000	1 644 000	128,2
2000	4 098 000	1 862 000	145,2

E.2 FUTURE INPUT ENERGY FOR THE DOMESTIC SECTOR AS A WHOLE

(a) Coal and Electricity

YEAR	INPUT ENERGY PER YEAR - MJ × 10^9							
	WHITE SECTOR		BLACK SECTOR		COLOURED AND ASIAN		TOTAL	
	ELECTRICITY	COAL	ELECTRICITY	COAL	ELECTRICITY	COAL	ELECTRICITY	COAL
1976	32,8	15,4	1,44	45,2	9,2	19,6	43,4	80,2
1980	41,2	15,3	2,88	29,1	13,0	18,5	57,1	62,9
1985	53,1	14,9	14,4	9,9	19,0	16,8	86,5	41,6
1990	66,1	14,2	19,8	11,4	25,9	14,0	111,8	39,6
1995	81,6	13,2	26,6	13,2	34,7	10,3	142,9	36,7
2000	98,4	11,8	34,9*	15,3*	44,7	5,4	178,0	32,5

*Based on extrapolation of trend from 1985

(b) Transport

YEAR	INPUT ENERGY FOR TRANSPORT - MJ × 10^9			
	WHITE SECTOR	BLACK SECTOR	COLOURED AND ASIAN SECTOR	TOTAL FOR THE DOMESTIC SECTOR
1976	66,3	11,6	8,6	86,5
1980	77,3	15,1	10,6	103,0
1985	94,2	31,7	22,0	147,9
1990	111,3	43,8	31,5	186,6
1995	128,2	51,0	39,1	218,3
2000	145,2	53,5	44,8	243,5

APPENDIX F.

INPUT ENERGY FOR THE COLOURED AND ASIAN SECTOR

F.1 ELECTRICITY AND COAL

1976 Average electrical input energy per household - White = 28 080 MJ
- Black = 12 528 MJ

(This is for Black households which have electricity)

- Coloured and Asian = 20 304 MJ

(Assumed to be average of Black and White sector values)

1976 Average coal input energy per household - White = 13 188 MJ
- Black = 73 138 MJ
- Coloured and Asian = 43 163 MJ

(Assumed to be average of Black and White sector values)

Coloured and Asian population - 1970 = 2 639 000
1980 = 3 448 000
1990 = 4 417 000
2000 = 5 625 000

Number of Coloured and Asian owned cars - 1970 = 89 000
1980 = 212 000
2000 = 1 264 000

This information may be combined to make the predictions set out in F.2.

F.2 COMBINED PREDICTIONS OF INPUT ENERGY FOR THE COLOURED AND ASIAN SECTOR

YEAR	POPULATION	NO. OF HOUSES*	INPUT ENERGY PER HOUSE - MJ		TOTAL INPUT ENERGY MJ × 10^9		NUMBER OF MOTOR CARS	PERCENTAGE USED DOMESTICALLY	TOTAL INPUT** ENERGY FOR DOMESTIC TRANSPORT MJ × 10^9
			ELECTRICITY	COAL	ELECTRICITY	COAL			
1976	3 124 000	453 000	20 304	43 163	9,2	19,6	162 000	68,0	8,6
1980	3 448 000	500 000	26 056	37 068	13,0	18,5	212 000	64,2	10,6
1985	3 933 000	570 000	33 246	29 450	19,0	16,8	475 000	59,5	22,0
1990	4 417 000	640 000	40 436	21 831	25,9	14,0	738 000	54,8	31,5
1995	5 021 000	728 000	47 626	14 213	34,7	10,3	1 001 000	50,1	39,1
2000	5 625 000	815 000	54 816	6 594	44,7	5,4	1 264 000	45,4	44,8

* Based on 6,9 people per dwelling

** Based on 78 000 MJ per car.

SAMPLE QUESTIONNAIRE

UNIVERSITY OF CAPE TOWN

(WITH WHICH IS INCORPORATED THE SOUTH AFRICAN COLLEGE)

ENERGY
UTILIZATION
UNIT

PRIVATE BAG, RONDEBOSCH
SOUTH AFRICA
7700
TEL.: 69-8531

1st July, 1976.

Dear Sir or Madam,

1976 ENERGY SURVEY

Since October 1973, when the Middle-East oil producing states increased the price of crude oil, a lot has been said regarding the "energy crisis". The restricted hours for the sale of petrol, speed limits and the price increase of oil-based products are some of the areas where the OPEC measures have been felt.

To enable an overall energy policy to be formulated for South Africa, the pattern of energy consumption needs to be established.

We need your help to find out how the domestic sector uses energy. That is the purpose of this questionnaire. Please fill it in and return it in the postage-paid envelope provided. If you feel someone else in your household is better qualified to answer the questions, please ask them to assist you. Remember that the questionnaire relates to energy usage on your property and should thus include the usage by servants or farm labourers.

We would like to receive replies by the **12th August, 1976.**

Also enclosed is a pamphlet which outlines areas in your home where you could possibly save energy. Keep it somewhere handy. You might like to refer to it at some later date.

Yours sincerely,

R. K. Dutkiewicz

Director

EXPLANATORY NOTES

1. The information obtained from you will be processed by computer and the form has been laid out accordingly.

2. Please mark the appropriate blocks with a cross or where applicable, write in the blocks provided.

3. Your name and address is not required for the survey and there is no need to sign the form.

4. Supply as many answers as you can and leave blank those that you are unable to give.

1. GENERAL INFORMATION

FOR OFFICE USE

a) City, town or district where you live? ..... [1–20] | [21–23] Area Code

b) The province that you live in ..... [24–40] | [41] Province Code

c) The number of persons (of all races) normally living on your property/in your flat

1) Adults ..... [42 43]

2) Children ..... [44 45]

3) Living-in servants [46 47]

d) The total income of you and your family (Place a cross in one block): Below R2 000 per annum [48]

Between R2 000 and R11 000 per annum [49]

between R11 000 and R20 000 per annum [50]

above R20 000 per annum [51]

e) The occupation of the head of your household ..... [52–68] | [69 70] Occup. Code

f) Total number of rooms in your home ..... [71 72] | [73–80: D S A 1]

g) Type of dwelling that you live in (Place a cross in one block) ..... a) House [1]

b) Flat [2]

h) What is your race group: 1:White ; 2:Black ; 3:Coloured ; 4:Asian ..... [3] | [73–80: D S A 2]
(Please place code number in the block provided)

FOR OFFICE USE

c) ELECTRIC GEYSER

1) Which of the following are supplied with hot water from an electric geyser or hot water tank:
(Please place crosses in the appropriate blocks)

1) Baths . . . . . . ☐ 23

2) Showers . . . . . ☐ 24

3) Water for dishwashing . ☐ 25

4) Water for washing clothes ☐ 26

2) If any of the above obtain hot water from an alternative source, please state what that source is.

Item	Source of hot water
Baths	
Showers	
Dishwashing	
Clotheswashing	

Source Codes

27 ☐☐☐ 29

30 ☐☐☐ 32

33 ☐☐☐ 35

36 ☐☐☐ 38

d) ELECTRIC WASHING MACHINE

1) If you use an electric washing machine, is the water heated within the machine, ... ☐ 39

(Place a cross in one block) or must hot water be added to the machine, ... ☐ 40

or do you use cold water washing powder . . . . ☐ 41

e) ELECTRIC HEATERS

1) How many heaters do you have of the following types? (Place number in the appropriate blocks)

1) Single-bar heater . . ☐ 42

2) Double-bar heater . . ☐ 43

3) Three-bar heater . . ☐ 44

4) Convective heater . . ☐ 45

5) Fan or blower heater . ☐ 46

f) ELECTRIC STOVE

FOR OFFICE USE

1) How many cooking elements are there on the top of your stove . . . . 47 [ ]

2) How many of these cooking elements are normally in use when cooking a meal . . . . . 48 [ ]

g) ELECTRICAL APPLIANCES

If you use any of the electrical appliances listed below, please state in the provided block, the frequency with which they are used.

1) Bread toaster - (number of slices of bread toasted per day) . . . . 49 50 [ ][ ]

2) Dishwasher - (loads of dishes washed per week) . . . . 51 52 [ ][ ]

3) Separate griller - (number of times used per week) . . . . 53 54 [ ][ ]

4) Electric kettle - (number of times used per day) . . . . 55 56 [ ][ ]

5) Electric coffee perculator - (number of times used per day) . . . . 57 58 [ ][ ]

6) Food mixer - (number of times used per month) . . . . 59 60 [ ][ ]

7) Vacuum cleaner - (number of times used per month) . . . . 61 62 [ ][ ]

a) Number of rooms cleaned each time the vacuum cleaner is used . . . . 63 64 [ ][ ]

8) Floor polisher - (number of times used per month) . . . . 65 66 [ ][ ]

a) Number of rooms polished each time the polisher is used . . . . . . 67 68 [ ][ ]

9) Refrigerator - if you have a refrigerator please place a cross in the block . 69 [ ]

10) Separate deep freeze unit - if you have a separate deep freeze, place a cross here 70 [ ]

11) Mains radio or hi-fidelity unit - (hours in use per day) . . . . 71 72 [ ][ ] 73 [D][S][A][ ][ ][ ][ ][:] 80

12) Electric blanket - (number of months in use per year) . . . . 1 2 [ ][ ]

13) Hair dryer - (number of times used per week) . . . . 3 4 [ ][ ]

14) Iron - (number of hours in use per week) . . . . 5 6 [ ][ ]

15) Television - (number of hours in use per week) . . . . 7 8 [ ][ ]

16) Clothes tumble drier - (number of hours in use per week) . . . . 9 10 [ ][ ]

Type and use code

17) Other (please specify here)____________________ ; Frequency of use __________ 11 12 [ ][ ] 13 14 [ ][ ]

18) Other (please specify here)____________________ ; Frequency of use __________ 15 16 [ ][ ] 17 18 [ ][ ]

h) AIR CONDITIONING UNITS

		FOR OFFICE USE
1) How many air-conditioning units do you have? (Please write the number in the block provided)	19 20	
2) How many of these units are in continuous use throughout the year?	21 22	
3) Of the remaining units, for how many hours per day are they in operation during (a) Winter	23 24	
(b) Summer	25 26	

i) ELECTRIC LIGHTING

1) How many electric lights do you have on your property of the following types (a) Fluorescent	27 28	
(b) globe (or filament or bulb or incandescent)	29 30	
2) On a typical night how many lights are burning on your property? a) Fluorescent	31 32	
b) Globes	33 34	
3) On a typical night how long do the lights burn for? (a) Fluorescent (Number of hours)	35 36	
(b) Globe (Number of hours)	37 38	73 D S A 80 S

4. COAL

If you do not use coal please go to section 5

		1 2 Usage Code
a) How much of the following coal types do your purchase and what was the total cost last year?		
a) Anthracite (bags) 3 5 ; Cost: R 6 8		
b) Bituminous coal (bags) 9 11 ; Cost: R 12 14		
b) What is the coal or anthracite use for? (Please place crosses in the appropriate blocks)		
a) cooking	15	
b) water heating for central heating systems	16	
c) water heating for domestic hot water	17	
d) open fire for room heating	18	
c) How many months of the year is an open fire in use (months)	19 20	
and how many hours per day during that period is it burning (hours)	21 22	

FOR OFFICE USE

5. OIL

If you do not use oil, please go on to section 6.

23 24 Usage Code

a) How much diesel fuel do you purchase per year for non-transport purposes? (litres) 25 29

Total cost (Rands) 30 33

b) For which of the following purposes is the diesel fuel used? (Cross the appropriate blocks)

(a) Cooking 34
(b) Water heating 35
(c) Direct room heating . . 36

c) How many months of the year is room heating carried out . . . . . (months per year) 37 38
and how many hours per day during that period is it carried out? . . (hours per day) . . 39-40

6. GAS

If you do not use gas, please go to section 7.

41 42 Usage Code

a) If you use bottled liquid petroleum gas (L.P.G.), how much do you consume per month (kilograms)? 43 44

Cost per month. . 45 46

b) If gas is piped into your property from an outside source, what is a typical monthly bill in:

(a) Summer (Rands) 47 48

(b) Winter (Rands) 49 50

c) What is the gas used for? (Place crosses in the appropriate blocks).
(a) Cooking 51
(b) Lighting 52
(c) Direct room heating . 53

d) How many months of the year is room heating carried out . . . . (months per year) 54 55
and how many hours per day during that period is it carried out . . . . (hours per day) 56-57

7. PARAFFIN

If you do not use paraffin please go to section 8.

58 59 Usage Code

a) How much paraffin do you use per month . . . . (bottles 60 62
or litres) 63-64-65

b) What is the paraffin use for? (Place crosses in appropriate blocks).
(a) cooking 66
(b) Lighting 67
(c) Direct room heating . 68

c) How many months of the year is room heating carried out . . . . . . (months per year) 69 70
and how many hours per day during that period is it carried out . . . . (hours per day) 71

73 D S A 6 80

FOR OFFICE USE

8. TRANSPORT

a) How many of the following modes of transport are used by your household?

(Consider only private transport)

MODE OF TRANSPORT	NUMBER IN USE	PETROL Cost per month (Rands)	DIESEL Cost per month (Rands)
Cars			
Van/lorry			
Autocycles			
Motorcycles			

b) If you are in the farming sector :

	PETROL litres per month	DIESEL litres per month	PARAFFIN litres per month
Electricity generation			
Stationary machinery drive			
Tractors, etc			

D S A 7

9. TRENDS IN ENERGY USAGE

a) If you intend purchasing any extra (not replacement) appliances for your home within the next year, please detail these below:

(Type, power, usage)

1)... 2) ....

3)... 4) ....

b) If you are considering changing from one fuel to another e.g. changing from an open coal fire to an electric heater or to oil heating, please give details below

(Pres. proposed use)

Present type of fuel used	Proposed type of fuel	Purpose of appliance
e.g. Coal	Electricity	Room heating

D S A 8

NB. PLEASE RETURN THE QUESTIONNAIRE AS SOON AS POSSIBLE IN THE ENVELOPE PROVIDED. NO STAMPS ARE NECESSARY