Energy use for space heating in RDP houses

A first indicative survey

January 2003

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January 2003
version 1.1

Contents

1. Background

During the preparation of a programme to improve the energy efficiency of low-income houses in South Africa, it became clear that, contrary to the expectations, little or no qualitative data were available on the amount of energy being consumed in low income households for space heating (Klunne 2002). Although several studies looked into the energy use of households, most of them are either outdated, fragmented, not distinguishing between the end use of the fuel used or incomplete.

To fill this gap the national Department of Housing in Pretoria will execute a large-scale energy use survey during the winter months of 2003. The results of that survey and associated data analysis will be used for the development of a carbon-emissions baseline, against which the effects of the proposed energy efficient housing programme will be evaluated.

The get a first magnitude of energy consumption and associated carbon emissions resulting from space heating in RDP type of houses, a small scale pilot survey was executed in August 2002 under 150 households in Gauteng, Mpumalanga and the Free State. The outcomes of that questionnaire survey are outlined in this report.

The reader needs to stay aware of the fact that the survey was only of an indicative nature. The sample size was only 150 households that were not selected to be representative for all low-income households in the country. However, the study does give us a first indicative value for the energy consumption.

The survey was carried out by Astron Research and Consulting CC from Secunda, while the questionnaire used was developed by Dieter Holm and Wim Klunne, who is also responsible for the data analysis. The completion of the questionnaires was done on a house-by-house basis by qualified surveyors.

During the survey a distinction was made between stand-alone houses and medium density houses, as the energy use patterns were expected to be different. Of the 150 questionnaires completed, 25 were in medium density houses.

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2. Interviewed households

The questionnaire survey was conducted end of August, early September 2002 in the following areas:

area	province	single units households	medium density households
Zamdela	Free State	25	
Qalabotjha	Free State	50	
Tembisa	Gauteng	45	
Ebony & Ivory Park	Gauteng	5	
eMbalenhle	Mpumalanga		25
TOTAL		**125**	**25**

Table 1 In total 150 questionnaires were completed

In the analysis of the results the two different housing situations will be treated separately.

2.1. Medium density houses

All the surveyed medium density houses are located in eMbalenhle in the Mpumalanga provinces, close to Secunda.
The houses have a size of 32 m^2 and have only one room (except for one house). Just over half of the houses have no kitchen, while nearly 40% of the houses do have the kitchen inside, nearly 10% has the kitchen outside the main house.
Most households consist of 3 or 4 persons with one or two being younger than 15 years of age.
From the 25 households interviewed, four were running a (small) business from home, mainly small tuck shops although one specialised in liquor.
All the houses in eMbalenhle are constructed using cement brick wall with asbestos cement roofs, without ceilings or insulation.

Electricity is supplied through prepaid meters with a tariff structure as show in Table 2

consumption / month	tariff Rand cent / kWh
0 - 40 kWh	free
41 - 60 kWh	34 c
61 - 260 kWh	40 c
> 260 kWh	31 c

Table 2 Electricity tariff structure eMbalenhle

2.2. Stand alone housing units

The single units in the survey are situated in four different locations. Each location has its unique design of the houses and hence size. The three sites in Gauteng (Tembisa, Ebony Park and Ivory Park) have houses of 30 m^2, Qalabotjha 38 m^2, while the largest houses were found at Zamdela (42 m^2).

The size of families in the single units is larger than found in the medium density units (average of 4.7 and 3.6 respectively). Figure 1 gives an overview of the household sizes and the number of persons under 15 years of age and the number of persons at home during daytime.

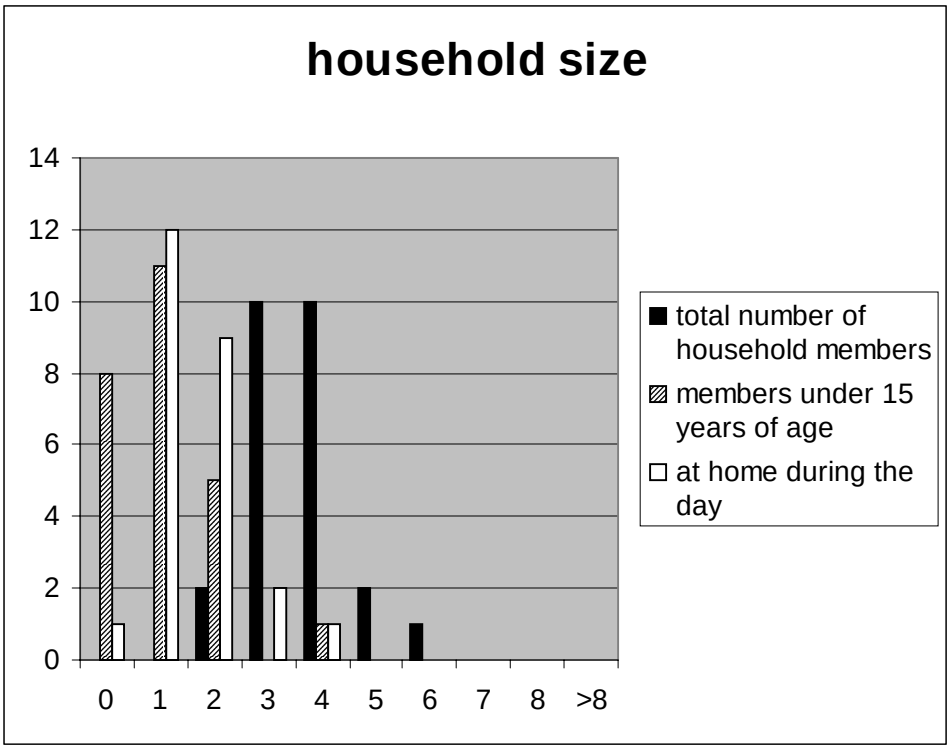


Figure 1 Household size for the stand alone units

The houses in the survey were mainly constructed using cement bricks (80%). The remainder was made of face bricks.
The roofing material of the houses is primarily corrugated iron (90%) with a few houses using asbestos cement. Only in 10% of the houses a ceiling was present, of which three-quarters did not have any insulation.

Figure 2 House at Zamdela (Note the absence of gutters and the additions constructed of steel sheeting)

Of the houses visited, 60 % did have the kitchen inside the main house, 25 % had no kitchen and the remainder used an outside kitchen.

Electricity at the surveyed locations was provided at only one standard rate, without any free monthly units, or stepped rates. In Zamdela 27.84c are charged per kWh, in Tembisa and Ivory/Ebony Park the rate is 35c/kWh.

3. Appliance ownership

The survey investigated the ownership of several types of appliances and their use.

Table 3 gives an overview of the appliances were identified during the survey. The assumed contribution to space heating and the electricity consumption are used to calculated the total energy consumption of the households.

appliance	assumed contribution to space heating	assumed electricity consumption (Watt/hour)
two plate stove	25 %	1275
electrical oven	25 %	3000
coal stove cast	50 %	
self made	50 %	
mbawula	75 %	
LPG	50 %	
electrical heater 1 bar	100 %	779
electrical heater 2 bar	100 %	1320
electrical heater 3 bar	100 %	2000
electrical heater oil	100 %	1240
paraffin heater	100 %	
ceiling fan	0 %	25
electrical blanket	0 %	133

Table 3 Identified appliances

Figure 3 gives an overview of the ownership in the single units. Note the high ownership of coal stoves and the low ownership of electrical heaters. Figure 4 provides this overview for the medium density units. Here the ownership of coal appliances ids predominant.

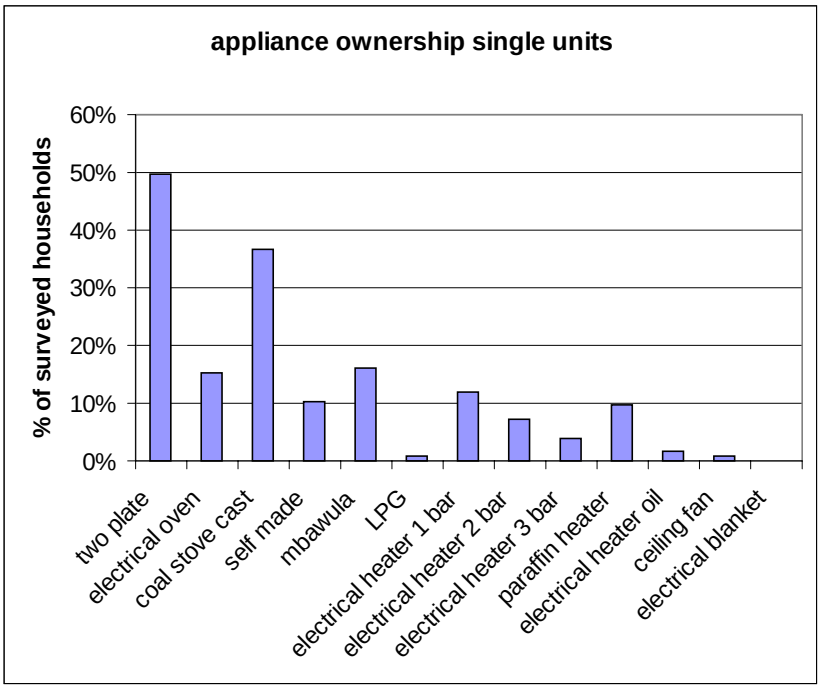


Figure 3 Appliance ownership in the single units

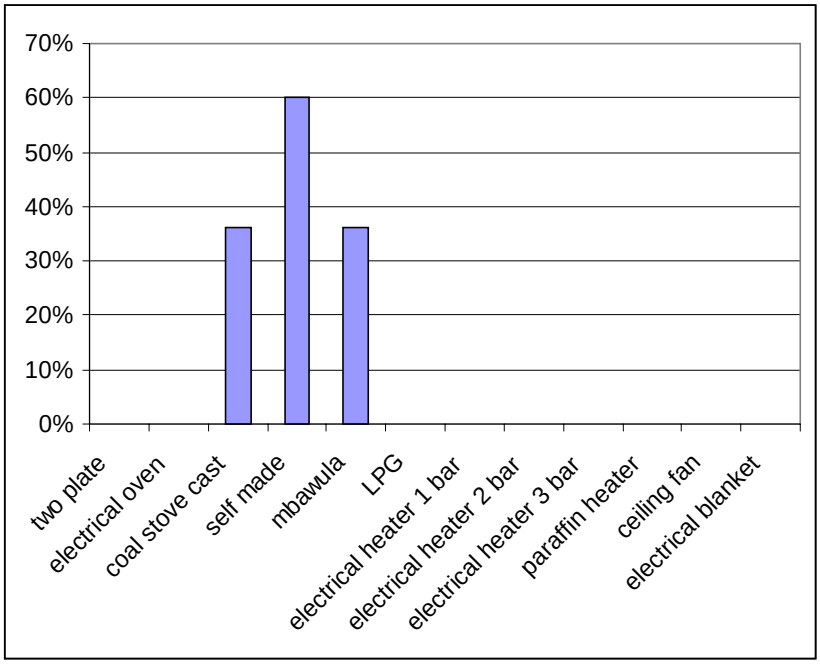


Figure 4 Appliance ownership medium density

4. Energy use patterns

Based on the 125 households interviewed in the stand-alone houses the following average household energy consumption can be calculated.

energy source	daily amount total (all devices)	devices for space heating only	including side effects cooking
electricity	5.5 kWh	0.8 kWh	1.5 kWh
coal	5 kg	1.1 kg	2.8 kg
wood	0.8 kg	0.1 kg	0.4 kg
paraffin	0.3 kg	0.3 kg	0.3 kg

Table 4 Average daily energy consumption per household (single units)

energy source	daily amount total (all devices)	devices for space heating only	including side effects cooking
electricity	0.2 kWh		
coal	11.6 kg	1.8 kg	6.3 kg
wood	2.4 kg	0.2 kg	1.3 kg
paraffin			

Table 5 Average daily energy consumption per household (medium density units)

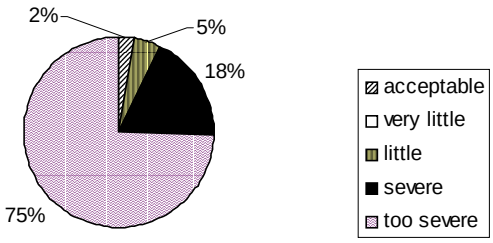
5. Air pollution

The current survey also looked into the prevalence of air pollution in the surveyed communities. Ideally this should be done using measuring equipment, measuring particles concentrations. However, due to the nature of the current survey, only the respondents' perception of the air pollution was asked.

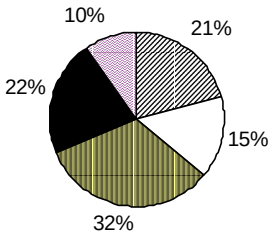
In the medium density areas, the respondents answered uniformly that air pollution was "too severe" in winter and "severe" in summer.

The reactions in the stand-alone areas can be seen from the graphs.

air pollution winter day stand-alone units



air pollution summer day stand-alone units



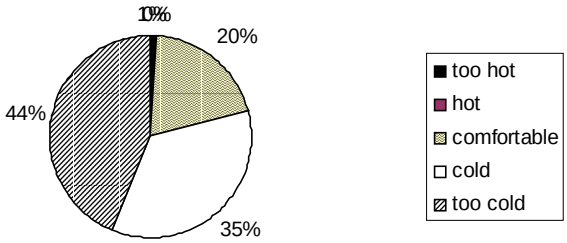
6. Indoor comfort

Besides measuring how much energy people are using trying to keep their house at a comfortable temperature, the questionnaire investigated people's perception of the comfort in the houses. Two sets of questions were asked in which the respondent had to classify the comfort inside the house on a scale from "too hot" to "too cold", for daytime and for the evenings. Both questions were asked for summer and winter conditions.

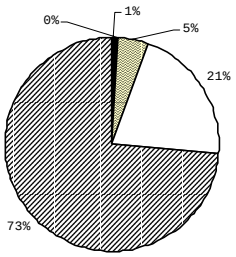
The respondents in the medium density houses thought very much in the same line. All respondents answered "too cold" in relation to the comfort level during winter day and evening. For summer, all respondents found it "too hot" during the day, while nearly all thought that as well for the evenings.

The responses for the stand-alone houses are summarised in the pie charts.

winterday comfort stand-alone units

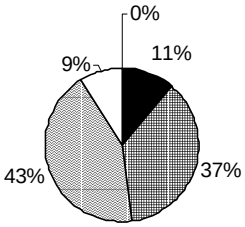


winter evening comfort stand-alone units



summerday comfort stand-alone units

summer evening comfort stand-alone



7. Carbon emissions

The energy consumption as calculated in the previous paragraph reflects an artificial distinction between space heating and non-space heating activities. However, using a stove to prepare a meal does heat the house as well (during winter and summer). Therefore part of the energy consumed for cooking activities is considered to contribute to space heating as well. The resulting carbon emissions are displayed in the table.

energy source	amount used	emission factor	kg CO_2
electricity	1.5 kWh	1.03 kg CO_2/kWh delivered	1.6
coal	2.8 kg	2.81 kg CO_2/kg	7.9
wood	0.4 kg	-	-
paraffin	0.3 kg	2.79 kg CO_2/kg	0.84
total			10 kg CO_2 / day

Table 6 Average household carbon emissions due to space heating (single units)

From the survey it became clear that the heating season is approximately 22 weeks long. At the start and the end of the heating season, people use less fuel then during the remainder. Hence the heating seasons is equivalent to 20 weeks of approximately 5 days a week heating for 5 hours /day. Using the results from the daily carbon emission calculations, the average household in the stand-alone units is emitting 1 ton of CO_2 per year due to space heating.

energy source	amount used	emission factor	kg CO_2
electricity		1.03 kg CO_2/kWh delivered	
coal	6.3 kg	2.81 kg CO_2/kg	17.7
wood	1.3	-	
paraffin		2.79 kg CO_2/kg	
total			18 kg CO_2 / day

Table 7 Average household carbon emissions due to space heating (medium density units)

In the surveyed medium density houses the households heat their house for approximately 800 hours per heating season. The calculated 18 kg CO_2 per day is based on just over 5 hours of heating per day. The total CO_2 emissions during the whole heating season will accumulate to 2.9 tons of CO_2.

8. Lessons learnt

During the course of executing the survey, several items emerged that need to be taken in consideration for the larger survey:

- The resistance against answering questions regarding the household income encountered was fiercer than anticipated. Although the question was asked as last question and had the opportunity of declining an answer, the word spread very fast that the surveyors were interested in the household income. People were afraid that the answer on the income question might be linked to the income at the moment of applying for the RDP houses. Although only the income when applying for the RDP subsidy house is relevant to the Department of Housing, and future income can never disqualify anyone for RDP subsidy, it was agreed with the community leaders not to provide stand number and the related income level to the Department.
- Security of the surveyors was once more highlighted during the execution of the survey when one surveyor got wounded in a shooting incident.
- A number of households were very reluctant to answer the questions as they were illegally renting the RDP house from the owner. Particularly the questions related to quality of the house might have been answered incorrectly.
- The time available to prepare the survey and do the actual fieldwork was very limited. The larger survey might need at least 3 months to prepare the fieldwork.

9. Conclusions

Although the data collected showed a wide spread in the answers and although the households interviewed might not have been a representative sample for the whole country, several conclusions can be drawn from the data analysis.

The energy sources availability, in quantity, quality and pricing, play an important role in the behaviour of the households in respect in energy consumption. However, for the standard RDP type of houses, the ballpark figure of 1 ton of CO_2 emissions per year related to space heating seems to be acceptable. For the medium density type of houses no reliable figure can be given due to the small sample size and the absence of geographical spread in the sample.

In the results for the medium density houses it is remarkable that none of the households is using electricity to heat the house, although they have a poverty tariff of 40 kWh free every month. This might be caused by several reasons, ranging from the high initial capital requirement for electrical heating equipment, social preferences and the inability to pay for the electricity needed after the 40 kWh have been used.

Owing to difficulties in obtaining reliable answers on the questions regarding the household income, it was not possible to determine any link between energy consumption, fuel source and income.

10. Literature

Klunne, W. E. (2002). Energy efficient housing in South Africa. Overview of current state of affairs.

Appendix 1: Questionnaire