

## **Southern Centre for Energy and Environment**

**Statistics, Library and Information Department**

# **SURVEY REPORT ON HOUSEHOLD FUEL USAGE CHARACTERISTICS FOR THE EVALUATION OF THE FEASIBILITY OF INTRODUCING COAL BRIQUETTES AS A HOUSEHOLD FUEL :**

*Harare and Chitungwiza.*

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the energy needs of the poor. Unfortunately, due to pressing economic reform programme constraints, petroleum fuel prices have been rising steadily, with 1996 recording three fuel price increases. This phenomenon is likely to continue being witnessed, as Government battles to cut down on costs such as subsidies and expand its revenue base from petroleum fuels. This then poses the question of energy availability to the poor section of our community. With wood-fuel becoming inaccessible and dearer and kerosene more expensive for larger families, what alternatives are present to save the low income group.

### **1.1 Objectives of survey**

The above question has prompted the carrying out of this survey to try and assess the possibility of introducing an alternative fuel to households in the low income section in the form of coal briquettes. This report is an analysis of the results of the survey to provide supporting data in an endeavour to gauge the willingness and acceptability of the fuel against a background of dwindling traditional fuels, rising costs and poverty alleviation. It also tests the ability of the households to purchase fuels and gives an indication of the possible areas of implementation.

## **2. THE HOUSEHOLD SURVEY BACKGROUND**

The targeted area for the dissemination of the coal briquettes is the population in Harare province. The coal briquette project fundamentally focusses on the low income group or the poor. For electrified households, it will be less feasible to change to coal briquettes, further supporting the original estimate that around 30% of households in the province require alternative energy sources.

The survey was carried out in the province of Harare, comprising Harare Rural, Harare Urban and Chitungwiza which constitutes about 20% of the total Zimbabwean population and over 50% of the urban population. The 1992 CSO Census showed that net population gain for Harare was 50.4% with in-migration being 56.4%. Life migration rates in the Harare district showed that, over 90% of persons born in Harare Urban are non-movers and loss of persons born in Harare Urban was mainly to Chitungwiza which is within the targeted area. The majority of the people surveyed (>90%) are urban dwellers, or exhibit strong urban dweller characteristics. This is so because even those that are classified as Harare rural are so close to the city and thus enjoy the facilities of the city.

The survey was carried out in October 1996. Due to the small sample size of about 150, it was not possible to treat the survey as a stand alone study, but to also heavily rely on the data from the Central Statistics Office (CSO), and from previous surveys by the Southern Centre. The most reliable source of information from the household was interviewed. This was usually the head of household or the spouse, or the eldest child who has had at least four years of secondary education. This was to ensure that the information collected was as accurate as possible and consistent from household to household.

For each household, background information was collected on physical location (address, date

of interview, and name and address of head of household). Statistics on household fuel consumption and general income indicators were then collected. The following is an analysis of the data that was collected. The analysis is closely linked to the required purpose of the survey, namely the introduction and dissemination of coal briquettes.

The coal briquette as a household fuel will be aimed at displacing wood and paraffin. This generally points the final user of this product as the poor households which constitute 41% in the target area. These households are predominantly native African households (comprising about 96.74%) with no noteworthy tribal affluence levels. However, a considerable proportion of these (2% nationally but concentrated in urban and mining centres) are Zimbabwean residents of either Zambian, Malawian or Mozambican origin.

### **3. HOUSEHOLD CHARACTERISTICS**

Zimbabwean households are basically patrilineal implying a husband headship of the household and in his absence, the wife. This is a feature typical of the traditional Zimbabwean family setup, a feature likely to be predominant in the near and far future. Another interestingly strong feature about the family setup is the existence of the extended family. In the urban centres such as Harare the feature is existent but not very strong mainly because of the associated high cost of urban life.

#### **3.1 Average Household Size**

The size of households in and around Harare is very variable, and the majority (90%) ranges from single person households to around 7 person households. About 20% of households in and around Harare are single person households. This feature is mainly influenced by employment opportunities that draw single persons to the city. Unless classified as high income earners, these households rely heavily on kerosene as a source of fuel for their cooking energy requirements. This is so because kerosene is more manageable for preparing small meals. The larger households with more than 4 persons per household (36% of total households) use more economic forms of energy for cooking and heating requirements. More than 60% of these households (1992 Census) are classified as low income earners, and thus use kerosene and/or wood as their main source of fuel. This roughly says that about a fifth of the households in and around Harare are large and lie in the low income category. Thus most of the low income groups would normally use wood-fuel as energy for cooking and heating. The target population for the coal briquettes is mainly composed of these, though the overall target population can be easily blown up to greater than 30% including those not classified above. The average household size is about 4.

#### **3.2 Employment and income**

The survey concentrated on the medium to low income categories. 45% of the families are in the middle income group and 50% are low income households. Low income group earn less than Z\$3,000 per month and middle income group have an income of above Z\$3,000 but below

Z\$15,000 per month. Most of the respondents in the greater Harare area are either formally employed or operate some business. About 67% from the survey obtain their income through salaries while only 8% operate businesses. The remainder are engaged in other activities. The sampled target group do own some assets of their own in the form of houses, vehicles and livestock. Over 37% own houses, 15% own cars, 16% have bicycles, about 7% own cattle<sup>2</sup>, 18% have poultry and about 15% have other types of livestock such as goats, sheep and pigs. Although over 99% of the people have some source of income 44% of them fall into the poor category and 23% are very poor. Therefore larger households, over 25% of the households have more than seven people, need a reliable long burning fuel to cook larger meals. Most respondents (90%) are willing to use coal briquettes as a fuel alternative provided it is cheaper than the conventional fuels they are using now.

### 3.3 Distribution by gender and age

The ratio of males to females was slightly greater than 1, that is, more males than females. Harare and Bulawayo province are the only in the whole country that exhibit such characteristics in the whole country. In the middle to high income areas of Harare urban, the ratios are nearly equal, but the low income households generally have more male members than female because the rural urban migration in search of employment is more common to men than women. 87% of households have 5 or less females while 81% of households have 5 or less males. This implies more larger male households than females. Children of lower school going age and preschool age are common to those families that are permanently urban dwellers. It is common for a household for the head of household, usually the husband to live in the urban centre with older school going age children, while the other spouse, usually the wife stays at the rural home with the rest of the family. This feature is very common, and largely contributes to the differences in the sex ratio. 40% of the households have no pre-school children while 41% and 12% have 1 and 2 pre-school children respectively. Table 1 shows the distribution of the age groups in Harare.

Table 1: Number of Members by age

Age	%
1. 0 - 5 years	20%
2. 6 - 12 years	10%
3. 13 - 18 years	10%
4. 19+ years	50%

Source: CSO

<sup>2</sup>These are mainly in Harare Rural category

### 3.4 Housing Characteristic

Zimbabweans in urban centres generally enjoy well built accommodation in terms of houses. Households in the high density areas of Mbare, Epworth and some parts of Highfield can be said to have the worst structured accommodation facilities. The case for Mbare is aggravated by the fact that it is the nearest low cost residential to the city centre. This has attracted large numbers of residents, making the township by far the most populated, dirtiest, and generally poorest in the whole province. The housing structures in this suburb comprises a core house surrounded by up to seven shacks accommodating more than ten households at each house stand or premise. The owner on the premises usually stays in the original core house and collects monthly rent from each of the households renting at the premises. The houses in this suburb are among the oldest in the whole town, accommodating about 10% of Harare's population. Officially, about 40% of the population in Mbare live in the Government owned flats of Matapi and Nyerere but the figures could be more since people of no fixed abode are many in this part of town. These rely heavily on paraffin as a source of fuel for cooking and heating water. They however are electrified, but only use this source of energy for lighting purposes, mainly on grounds of cost.

The inhabitants of the rest of the other high density suburbs (middle to low income ) groups including all of Chitungwiza except for St. Marys exhibit similar housing characteristics. The general setup is such that the owner of the house uses the main rooms of the house namely kitchen, bedroom, sitting/dining room and main toilet and bathroom facilities. The remainder of the rooms, usually two to three rooms are rented to small family households. Thus each house or premises accommodate on average two to four households. About 70% of the houses are occupied by their owners. The period of stay in the households varied from as little as a month to as much as 70 years. Most of the houses have less than 5 rooms with about 80% households living in 5 or less roomed houses. About 50% live in 1 to 3 roomed houses.

The duration of stay at a particular premise depends mostly on ownership status, kind of employment and the reason for staying in Harare. About 95% (Southern Centre 1994) of households owning houses stay at these always. The rest of the households stay according to their income levels and employment status. Poorly paid residents opt to stay in cheaper areas. It is also common for a household to change from one landlord to another within the same suburb on cost grounds. As soon as one starts earning a descent income the trend is generally to move to more expensive areas, though some few households have opted to stay in their original areas despite changes in fortunes. On average, a household does not staying for a period not exceeding 2 years in one house, unless they have ownership. It is common practice for landlords to keep changing tenants in a bid to hike rental fees.

### 4. ELECTRIFICATION

As most of these households (about 73%) are electrified, all the households at the premises generally have access to electricity for lighting purposes. Only 5% have had their electricity disconnected. About 80% of dwelling units in Chitungwiza are electrified. The figure stands at

75% for Harare Urban, and 40% for the rural areas in the province. The majority of the renting households however still rely on kerosene for cooking, mainly aimed at avoiding large bills from the landlord. Actually, in many instances, the landlord charges electricity bills according to how many electrical appliances the tenants are using, rather than the size of the bill they receive from ZESA.

All households with access to electricity use this fuel for lighting. Households in owned accommodation use on average four rooms, and five electric bulbs for lighting. About 80% of households use between zero to 5 bulbs while some larger households can use as many as 17 bulbs but only 5% use more than 10 bulbs. These families usually have other electrical appliances ranging from large size electric cookers (61%), refrigerators (37%), Televisions (57%), radios (69%), fans, irons to other minute kitchenware gadgets. Households in rented houses have many varying characteristics. The majority of these have basic apparatus such as bulbs, hotplates, irons etc.

## 5. WATER AND OTHER SOCIAL FACILITIES

Harare province boast a good network of piped water. 92% of households have water on their premises. A further 4%, predominantly from Epworth, have access to a community tap. About 2% of the households obtain water from wells which they go on to boil before use. Some Harare rural households get their water from boreholes, this is only 3% of the total sample of households.

Most of the target population has easy access to many social facilities. The distance to bus stations varies from 100 metres to about 3 kilometres. Less than 10% of the sampled households travel more than 1 kilometre to a bus station. Distance to foodmarkets varies from 100 metres to about 5 kilometres. However, less than 13% travel more than 1 kilometre to get to foodmarkets, and of that less than 1 percent travel more than 3 kilometres.

Since 92% of the households have tapped water installed at their houses the distance to the source of drinking water is nil, the remainder either uses community taps around street corners 50 metres to 800 metres from these houses or borehole water.

## 6. HOUSEHOLD FUEL

The main source of energy for cooking are wood, electricity and paraffin. Since the targeted area is well electrified most of the households use electricity for cooking (47%), while the rest use either wood(23%) or paraffin (30%). Those households that use electricity sometimes do use wood-fuel for heating or paraffin for cooking during blackouts. However, households that use wood-fuel as a primary form of energy for cooking do use paraffin interchangeably with wood depending on what they are cooking and when they are doing so. Table 2a and 2b show the household fuel mix from the survey.

Table 2a: Fuel mix for cooking and lighting

	Fuel for cooking
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Fuel for lighting		Electricity	Kerosene	Candle	Total
	Wood	17.24%	45%	26.67%	22.95%
	Electricity	63.22%	10%	-	46.72%
	Paraffin	19.54%	45%	73.33%	30.33%
	Total	100%	100%	100%	100%

Table 2b: Fuel mix for cooking and heating

		Fuel used for heating					
		Wood	Paraffin	Electricity	None	Unspecified	Total
Fuel used for cooking	Wood	48%	17.24%	16.33%	-	10%	22.81%
	Electricity	36%	6.9%	71.43%	100%	50%	45.61%
	Paraffin	16%	75.56%	12.24%	-	40%	31.58%
	TOTAL	100%	100%	100%	100%	100%	100%

Table 3 shows the distribution of those houses that have been electrified and their cooking preferences.

Table 3: Distribution of electrified households using different fuels.

		Fuel used for cooking			
		Wood	Electricity	Paraffin	TOTAL
Electrification status of the house	Installed	64.29%	96.46%	43.24%	72.95%
	Installed but disconnected	-	1.75%	13.51%	4.92%
	Not installed	38.71%	-	40.54%	20.49%
	Other	-	1.75%	-	0.82%
	Not specified	-	-	2.7%	0.82%
	TOTAL	100%	100%	100%	100%

Electricity users mainly use electric cookers or hotplates as their main apparatus for cooking. Paraffin users inevitably have to use kerosene stoves which vary in size depending on the cooking requirements of the family. Wood-fuel users use wood-stoves of different makes ranging from three stone improvised cooking facilities to slightly neater metal grate stoves.

Most households with access to electricity do use electricity for lighting even if they do not use it for cooking. 71% of the interviewed sample do use electricity for lighting compared to 47% who use electricity both for cooking and lighting. Thus about 25% of the households prefer cleaner lighting but cannot afford to use electricity for cooking. This can safely be concluded to constitute part of our poor section of the target area. Kerosene is another heavily used fuel for lighting with 17% of the households using it and the remaining 12% using candles. Nobody uses firewood for lighting.

The Zimbabwean climate is generally cool winters to very hot summers. It is only cold for about 3 months in the year. The remaining 9 months are generally warm and there is no real demand for heating houses. However, Zimbabwean winters can be quite cold, and when it happens families with electricity and can afford to heat their rooms electrically (43% of the households) do use electrical heaters but for periods not exceeding 2 hours per day. About 8% of the families do not heat their homes at all, while 22% prefer to use firewood to heat their homes. Those who use wood do have chimneys in their houses and they will be living in owner occupied houses. 17% of the owner occupied houses prefer to use firewood for heating compared to 9% for rented houses. Landlords dislike their houses to be smudged with smoke from firewood used by tenants. The main apparatus use by those that heat their rooms electrically is the electric heater ranging from 1000W 1 bar heaters to upwards of 2000W heaters with more sophisticated facilities.

Water heating is another energy consuming activity. Households with geysers spend over 50% of their money on heating water. Those with no geysers heat their water on the electric stove, which is also energy consuming. About 50% of the households interviewed used electric stoves to heat water. 14% use the fireplace to heat water usually outside the house. The remainder uses other types of stoves such as kerosene stoves or geysers.

Most the energy used by the families is purchased and only about 4% is either collected or given. Thus 96% of the targeted population buys energy to fulfil their cooking, lighting and heating requirements. This is to be expected in an urban setup where the only 'free' energy source, firewood, is not available in the form of forests or woodlands. It would not even be worthwhile for an urban dweller to attempt to venture into the city outskirts to collect firewood due to the distance restrictions and costs involved. One would have to travel up to 50 kilometres to source good firewood species and spend quite a lot to transport the firewood from those points. Somebody who affords this type of operation usually would not use firewood as a primary fuel.

## **7. ENERGY EXPENSES**

Monthly bills of those families that use electricity range from as little as Z\$16 for small families to as much as Z\$1200 for larger families. Only 7% of the population had bills above Z\$500 of which only 2% were above Z\$1000 per month. Electricity costs about Z\$0.19 per cents per unit.

Wood expenses ranged from Z\$10 to about Z\$640 per month depending on the size of the family and uses of the firewood. Less than 10% use more than Z\$50 for wood-fuel every month. The



average woodfuel consumption and expense for heavy wood users is about 22.5 kg and \$Z45 per day respectively. Seasonal wood users would spend about Z\$26 for about 12.5 kg per occasion. Woodfuel costs about Z\$2.0/kg. Households use 15 to 360 kilograms of wood every month.

Those households that use paraffin for either cooking/and or lighting spent from as little as Z\$5<sup>3</sup> to as much as Z\$600<sup>4</sup> per month. Heavy paraffin users (classified as those that use more than 10 litres per week) consume an average of about 22.5 litres per week at a cost of about Z\$35. Light paraffin users (those using it mainly for lighting), and consume not more than 10 litres per week pay an average of Z\$10 per week for about 7.5 litres. Paraffin costs Z\$1.40/litre and is very accessible at petrol service stations in the residential areas.

### 7.1 Other expenses

Other monthly household expenses include maize meal, other foodstuffs, rental and rates, water, school and transport costs. Food expenses range from Z\$50 to Z\$3500. Only 13% have food expenses exceeding Z\$1000. 36% spent over Z\$500 on food and only 5% spent less than Z\$100. Small families consume from about 10kg of maize meal which approximately Z\$25. Bigger families consume 750 kg of maize meal, although only 5% consume more than 100kg.

House rentals vary from Z\$75 to about Z\$950. The average rental is about Z\$155 of which 6% are above Z\$300. Water is very cheap especially in the low income suburbs, where city authorities have a deliberate policy to subsidise water and other rates in those communities. Water bills can be as low as Z\$5 to over Z\$1000. Water costs, however, rise rapidly when consumption exceeds 34 units. Thus large families or houses with many families suffer more when they inevitably exceed the 34 unit mark into the higher tariff range. Thus it is not surprising to get astronomical water bills in larger households.

School fees is one of the biggest expense that families have to shoulder, with some paying as much as Z\$10,000 at the beginning of every term. Low income schools are generally cheaper than exclusive schools, but even low income parents want the best for their children, and so they would rather pay higher fees to have their kids sent to good schools. Hence school fees bills range from Z\$150 to as high as Z\$10,500. However, only 6% pay over Z\$1000 for school fees.

Chitungwiza residents pay more for transport than their Harare colleagues due the distance between the two places. However, Chitungwiza residents benefit from increased competition and the presence of mass transport systems which helps reduce the overall transport costs. Being a largely low income area also means that residents do not make unnecessary journeys to cut down on this expense. The commuter omnibuses charge Z\$2.6 per trip to Chitungwiza while the faster

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<sup>3</sup>Low paraffin users are predominant wood-fuel users who only use paraffin for lighting but not for cooking.

<sup>4</sup>These large households who use paraffin for heating, lighting and cooking

combis charge Z\$3.50. In Harare transport charges range from Z\$1 to about Z\$3 for outlying suburbs. Only 16% pay over Z\$200 per month on transport. Other expenses vary from as little as Z\$15 to as much as Z\$1000. Over 63% of the respondents indicated that they do not have many other expenses apart from the basics. This is not unusual considering the economic hardship which has gripped the Zimbabweans since the introduction of economic reform programmes.

## **8. FUEL CONCERNS**

The survey revealed that about 67% thought the present fuels they are using are expensive. Over 31% however, had no complaints about the present fuel prices or performance. About 1% gave other reasons such as unreliability, slowness in cooking and smell. The reason they continue using the same fuel is because they either have no alternative like electricity, or the fuel is the cleanest and/or cheapest available to them. Apparently nothing much is being done to conserve energy except for a few cases where respondents pointed out that they switch off unnecessary lights and discontinuing usage of heaters or fans among other measures.

### **8.1 Firewood concerns**

Wood-fuel is used by about 22% of the population. Although most of these from the Harare Rural category typically collect or gather fuelwood, about a third of the wood users buy their fuel from wood vendors at markets. The head of the family is usually responsible for obtaining wood-fuel as indicated by over 56% of the wood-using respondents. The child also plays an important role in fuel procurement with about 20% of the children having fuel responsibilities now.

Wood is very accessible to both urban buyers and rural collectors. About 34% obtain their wood within a kilometre from their homes while 50% have to travel only 2 kilometres. The remainder only have to travel up to 4 kilometres. Most of the wood-users buy or collect wood on foot (57%), others use wheel barrows or bicycles (19%), and public transport (12%). The remaining wood users use various other means to transport the wood.

Fires are allowed to burn from under an hour to about 8 hours<sup>5</sup> (less than 1%). About 23% burn fires for 1 hour, 42% for about 2 hours and about 26% for 3 hours. The fires are usually on at major cooking times, that is, in the morning(for breakfast), around noon(for lunch) and in the evening(for supper). Most of the fires are lit for the purposes of cooking (about 88%), for heating (4%) and for lighting (8%). Fire cannot be used for lighting in urban areas due to the kind of housing structures found there, but it is possible in the rural set up where sometimes the kitchen can serve as the bedroom.

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<sup>5</sup>This situation applies in winter and in Harare Rural where families stay at home and have to keep warm. The winter season does not have much activity after harvesting has been done and many families apart from winter ploughing stay at home.

## 8.2. Fuel changes - Coal Briquette?

Most of the interviewed people would change to another fuel(93%). The remaining 7% would not want to change from the wood they are currently using. 57% of the wood-users would prefer using electricity while 4% prefer kerosene. A further 39% would prefer other fuels other electricity and kerosene.

90% of the respondents would want to use coal briquettes after the brief explanation by enumerators. This shows confidence in a product which they have never seen or is it desperation for an alternative? Only 10% are not interested in coal briquettes. The main reason the positive respondents would use coal briquettes is if it is cheaper than the current fuels they are using. So pricing of the coal briquette is of prime importance in the final dissemination of the fuel. Most thought they would use it for cooking but worried about whether it would cause smoke - whether it is a clean fuel<sup>6</sup>. Most people target their worries about coal briquettes in the same way they view raw coal. This also brings the issue of toxicity of coal fumes, a number of people have died due to inhaling toxic coal fumes in closed environments.

## 8.3 Issues about coal briquettes

Those willing to use coal briquettes would rather buy them from the wood vendors or paraffin vendors(petrol service stations). Others would prefer buying from business service centres. Half of the respondents prefer buying briquettes in cheap plastic bags whilst others prefer buying in sacks. Over 84% would rather buy small packs of 5kgs, this could be an indication of scepticism<sup>7</sup> or storage problem worries. Interestingly 30% prefer red packs and another 30% prefer black. The remainder do not think the colour of pack really matters. This can lead to a conclusion that only 30% really think the coal briquettes are a dirty fuel. Although some respondents would go for long shaped coal briquettes, most of them think the shape is immaterial, as long as the shape is acceptable.

## 9. FIREWOOD SOURCING AND DISTRIBUTION

A number of wood, paraffin and coal vendors were visited during the course of the survey in a bid to assess the processes of wood sourcing, transportation, distribution and marketing strategies that are currently being used. Since the coal briquette project is mainly targeted at displacing wood, 87% of the vendors visited were wood vendors.

Wood consumption was estimated to occupy about 10% of the market share of present energy

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<sup>6</sup>Many people would not normally use coal because of this reason. Tenants would not be permitted by landlords to use smoky fuels in their houses, to keep them smart for other possible tenants.

<sup>7</sup>Maybe people would like to buy small packs and test whether this new fuel is anything close to their expectations then proceed to buy in bulk after initial trials.

mix. The vendors are acquiring the wood from as far as Chivhu farms, 160 km away from Harare. Two thirds of the vendors or their suppliers obtain their firewood from more than 50km from Harare. Almost all transporters use lorries to supply Harare with loads ranging from 2 tonnes to as much as 1000 tonnes with an average load of about 8 tonnes per trip. The cost of the wood depends on a number of parameters among them, quality of wood on burning (some types of wood produce a lot of smoke on burning or they have poor flame, etc), dryness, distance from source and other market forces. The suppliers charge an average of about Z\$800 per tonne for the wood most of which they get from farms and woodlands. The vendors then sell the firewood at an average of Z\$2.00 per kg. The prices do vary slightly in winter when there is higher demand by an average of 50 to 100%. Wood prices are likely to continue rising due to higher transport costs as sources of wood become further away aggravated by fuel price increases as well as other running costs of transporters.

Woodfuel suppliers obtain their wood 'free' of charge from farms and other woodlands. Occasionally they pay some token to farm owners, but this is not much. Wood suppliers could not be drawn as to how much they acquire their wood at. The charges they quote wood vendors are merely to offset their transport and distribution costs.

67% of the wood vendors are happy with the supply of wood but the remaining 33% are worried about the stability in the light of deteriorating wood sources around Harare. All paraffin vendors are satisfied with the stability of their supplies and the households have easy access to these vendors who are mainly petrol service stations. Households barely walk more than 2 kilometres to get to a paraffin vendor.

However, some wood vendors are worried about the high transport charges, and some would prefer some formal markets to operate from. Some vendors complain of having to buy substandard types of wood to fulfil their market demands. Most of the vendors were willing to sell coal briquettes although petrol service stations were not sure their mother companies would allow them to sell coal briquettes either a side activity or as part of their mainstream activities.

## **10. POSITION OF LOCAL ENTREPRENEURS**

Alongside the survey, a number of interviews and meetings were held between JICA personnel and local entrepreneurs coordinated by Southern Centre. Some of the local entrepreneurs in Government and the private sector are given in Appendix 2.

It was important to meet and derive local opinion of possible actors in the coal briquette provision ranging from the coal and other raw material suppliers, coal distributor, relevant Government departments, plant manufacturers as well as marketing agents.

Coal suppliers (Wankie Colliery Company-WCC) is willing to sell off some of its coal fines since at the moment the coal fines are just but a nuisance, piling up in WCC's backyard and posing possible environmental hazards. WCC would really appreciate if it found a market for its coal fines apart from the brick moulders who have provided a small but worthwhile market.

The Southern Centre/JICA team also visited Geo Elcombe, a local coal merchant and transporter and discussed at length their current services, and how they could be expanded to incorporate the coal briquette project. Geo Elcombe expressed interest in collaborating in the project and gave estimates of possible costs associated distributing coal and other raw materials such as molasses.

A visit was also paid to Triangle Sugar Estates and the local ethanol plant to see if molasses or bagasse could be used as an ingredient in the coal briquette. Triangle Ltd.'s Technical Director expressed a lot of interest in briquetting and is even looking at bagasse briquettes since they have excess bagasse which they dispose of by burning in their boilers. They can also supply molasses from since JICA requirements are only minimal compared to total molasses production. Another product from Triangle Ltd. is stillage, which is currently being treated as waste posing environmental concern and could be harnessed as an ingredient in coal briquette manufacturing.

The coal briquetting plant location has not yet been positively identified but a tentative spot has been identified at the Scientific and Industrial Research Development Centre(SIRDC). Meetings were held between SIRDC and JICA/Southern Centre team and the roles of SIRDC in the project were clarified as the Government arm to the project. Other meetings were also held with the local city authorities to obtain information on land and commodity prices as well as city building standards. The Harare City Council has no unusual building standards and would be willing to expand its industrial base through establishment of such factories. As long as JICA meets certain minimum standards, the city authorities would grant permission to build their factory. Land is available at competitive prices and it is up to JICA to choose a factory spot which is accessible and convenient for its operations.

The team also visited a local boiler and fabricating company - Cochraine Engineering, a reputable company in the manufacturing of boilers, kilns, heat exchangers, etc for the Southern African region. The chief executive of the company showed immense interest in the project and promised that his company could accomplish the job of building the necessary kilns with ease.

## **11. CONCLUSION**

The cost of the coal briquette is the major acceptance factor in this study. All positive respondents would change from current fuels to coal briquettes if and only if the equivalent fuel is reasonably priced.

It is important to note therefore that the current and projected fuel prices of wood and paraffin are not cheap to the target community, which is the low income section. The historical fuel price buildup in Appendix 1 shows that the energy costs are going to escalate in the future due to a number of reasons. Wood costs are mainly affected by transport charges and transport charges are affected by distance to source and vehicle running costs. Wood is likely to go up due to rapid depletion of woodlands around Harare. Transporters now have to travel as far as Chivhu, 160 km away. This is worsened by the depletion of wood with good burning properties. Petroleum fuel increases will also force suppliers to up their selling prices. Spare parts are also

very expensive and in short supply in Zimbabwe due to tariff restrictions to protect the local vehicle manufacturers.

Therefore, the implementation of the project should critically consider a cheap coal briquette at the end to displace other conventional fuels currently in use.

Coal briquette would most likely find a ready market in suburbs such as Mbare (where the population is greatest and density is highest), Rugare, Mabvuku, Tafara, Dzivarasekwa, Highfield and Mufakose (some of the largest low income suburbs in Harare), Epworth (which is really a peri-urban community having its own local authority board but gradually developing into an urbanised settlement), most of Chitungwiza (basically a low income dormitory town for Harare with almost half a million people), and Hatcliffe (a rather new low income settlement - would be ideal if coal briquette plant is set up at SIRDC). Other important suburbs include Kuwadzana, Warren Park, Kambuzuma, Sunningdale, Glen Norah, Glen View and Budiro, generally modern high density suburbs with a much younger average population. Most of these suburbs have well positioned service centres where coal briquettes can be sold as well as established wood vendors who can also assist in dissemination.

# **TECHNICAL ANNEX**

## APPENDIX I

### Energy Prices in Zimbabwe

(Z\$)

	1996	1995	1994	1993
Kerosene	1.48	1.33	0.92	0.92
Jet A1	2.58	2.07	1.79	1.75
Diescl	3.31	2.01	1.84	1.84
Gasoline	4.15	3.16	3.06	3.06
Av.Gas	4.26	3.34	2.90	2.86
LPG	6.39	5.69	5.03	5.03

All liquid fuels are in \$/litre and LPG is in \$/kg



## **APPENDIX 2**

### **SURVEY RESULTS**

# SURVEY RESULTS

## Interview Status

	Actual Values	Percent
1. Willing	122	100.00
2. Not willing	0	0
Total	122	100.00

## Head of Household present/Absent

	Actual Values	Percent
1. Present	44	36.07
2. Absent	78	63.93
Total	122	100.00

## Nationality of Head of Household

	Actual Values	Percent
1. African	122	100.00
2. European	0	0
Total	122	100.00

## Gender of Head of Household

	Actual Values	Percent
1. Male	106	86.89
2. Female	16	13.11
Total	122	100.00

Number of rooms in a house

Number	Actual Values	Percent
1	2	1.64
2	8	6.56
3	17	13.93
4	10	8.20
5	19	15.57
6	14	11.48
7	20	16.39
8	43	10.66
9	8	6.56
10	2	1.64
12	3	2.46
13	1	0.82
14	2	1.64
15	1	0.82
17	2	1.64
Total	122	100.00

Number of Male Household Members

Number of males	Actual Values	Percent
0	1	0.82
1	22	18.03
2	34	27.87
3	17	13.93
4	29	23.77
5	9	7.38
6	4	3.28
7	1	0.82
8	3	2.46
10	2	1.64
Total	122	100.00

Number of Female Household members

Number	Actual Values	Percent
0	7	5.79
1	21	17.36
2	24	19.83
3	27	22.31
4	16	13.22
5	13	10.74
6	3	2.48
7	3	2.48
8	3	2.48
9	2	1.65

10	1	0.83
22	1	0.83
Total	121	100.00

Number of Household Members Below 5 years

Number	Actual Values	Percent
0	48	39.34
1	50	40.98
2	15	12.30
3	8	6.56
5	1	0.82
Total	122	100.00

Number of Household Members between 6- 12 years

Number	Actual Values	Percent
0	50	40.98
1	32	26.23
2	27	22.13
3	12	9.84
8	1	0.82
Total	122	100.00

Number of household Members between 12-18 years

Number	Actual Values	Percent
0	49	40.16
1	38	31.15
2	26	21.31
3	8	6.56
4	1	6.82
Total	122	100.00

Number of Members above 19 years

Number	Actual Values	Percent
0	1	0.82
1	12	9.84
2	46	37.70
3	26	21.31
4	18	14.75
5	7	5.74
6	3	2.46
7	2	1.64
8	2	1.64
9	4	3.28
13	1	0.82
Total	122	100.00

Main Source of Income

	Actual Values	Percent
0. Unspecified	1	0.83
1. Salary	81	66.94
2. Business	10	8.26
3. Other	29	23.97
Total	121	100

Duration of stay in dwelling/months

Duration/months	Actual value	%
1	3	2.46
4	4	3.28
5	1	0.82
7	1	0.82
8	1	0.82
11	1	0.82
12	5	4.10
16	2	1.64
24	8	6.56
36	6	4.92
48	2	1.64
60	2	1.64
72	5	4.10
84	1	0.82
96	7	5.75
108	1	0.82
120	6	4.92

132	3	2.46
144	3	2.46
156	2	1.64
168	5	4.10
180	5	4.10
192	11	9.02
204	3	2.46
216	1	0.82
228	1	0.82
240	6	4.92
276	4	3.28
288	2	1.64
300	1	0.82
312	7	5.74
336	1	0.82
360	4	3.28
384	2	1.64
432	1	0.82
624	1	0.82
720	1	0.82
812	1	0.82
Total	122	100.00



Housing status(own/rented)

	Actual Values	Percent
1. Owned	86	70.49
2. Rented	32	26.23
3. Other	1	0.82
4. Unspecified	3	2.44
Total	122	100.00

Number of rooms in dwelling

Number	Actual Values	Percent
1	23	18.85
2	19	15.57
3	177	13.93
4	26	21.31
5	13	10.66
6	5	4.10
7	8	6.56
8	4	3.28
9	3	2.46
12	1	0.82
14	1	0.82
17	1	0.82
44	1	0.82
Total	122	100.00

Number of Bedrooms in house

Number	Actual Values	Percent
0	1	0.82
1	81	66.39
2	19	15.57
3	8	6.56
4	6	4.92
5	4	3.28
6	1	0.82
7	2	1.64
Total	122	100.00

Number of Sitrooms in House

Number	Actual Values	Percent
0	32	26.23
1	82	67.21
2	6	4.92
3	2	1.64
Total	122	100.00

Number of Outrooms in house

Number	Actual Values	Percent
0	98	80.33
1	16	13.11
2	3	2.46
3	3	2.46
4	1	0.88
7	1	0.82
Total	122	100.00

Number of Bathrooms in house

Number	Actual Values	Percent
0	51	41.80
1	70	57.38
3	1	0.82
Total	122	100.00

Number of Toilets in house

Number	Actual Values	Percent
0	6	4.92
1	115	94.26
3	1	0.82
Total	122	100.00

Number of Other Rooms in house

Number	Actual Values	Percent
0	10	8.20
1	83	68.03
2	3	2.46
3	21	17.21
4	2	1.64
5	3	2.46
Total	122	100.00

Electrification status

	Actual Values	Percent
0. Unspecified	1	0.82
1. Installed	89	72.95
2. Installed but disconnected	6	4.92
3. Not installed	25	20.49
5. Other	1	0.82
Total	122	100.00

Possession of Bulbs in house

Number	Actual Values	Percent
0	26	21.49
1	15	12.40
2	14	11.57
3	8	6.61
4	19	15.70

5	14	11.57
6	4	3.31
7	6	4.96
8	4	3.31
9	5	4.13
10	1	0.83
12	1	0.83
13	2	1.65
14	1	0.83
17	1	0.83
Total	121	100.00

Possession of electric Cooker in house

Number	Actual Values	Percent
0	41	33.61
1	74	60.66
2	4	3.28
3	3	2.46
Total	122	100.00

Possession of Fridge in house

Number	Actual Values	Percent
0	74	60.66
1	45	36.89
2	2	1.64
3	1	0.82
Total	122	100.00

Possession of Television in house

Number	Actual Values	Total
0	48	39.34
1	69	56.56
2	3	2.46
3	2	1.64
Total	122	100.00

Possession of Radio in house

Number	Actual Values	Percent
0	31	25.41
1	84	68.85
2	5	4.10
3	1	0.82
4	1	0.82
Total	122	100.00

Possession of Other electrical appliances

Number	Actual Values	Percent
0	55	45.08
1	24	19.67
2	16	13.11
3	13	10.66
4	8	6.56
5	4	3.28
7	1	0.82

18	1	0.82
Total	122	100.00

Appliance used for Heating

	Actual Values	Percent
0. Unspecified	11	9.40
1. Electric stove	60	51.28
2. Fireplace	17	14.53
3. Other stove	27	23.08
11	1	0.85
33	1	0.85
Total	117	100.00

Main source of energy for Cooking

	Actual Values	Percent
1. Wood	28	22.95
2. Electricity	57	46.72
3. Paraffin	37	30.33
Total	122	100.00

Main Source of Energy for Lighting

	Actual Values	Percent
1. Electricity	87	71.31
2. Paraffin	20	16.39
3. Candle	15	12.30
Total	122	100.00

Main source of energy for Heating

	Actual Values	Percent
0. Unspecified	9	7.96
1. Firewood	25	22.12
2. Paraffin	29	25.66
3. Electricity	49	43.36
4. Not in Use	1	0.88
Total	113	100.00

Electricity units used per month

Number	Actual Values	Percent
0	46	76.67
1	2	3.33
2	1	1.67
8	2	3.33
10	1	1.67
15	1	1.67
16	2	3.33
18	1	1.67
20	2	3.33
32	1	1.67
360	1	1.67
Total	60	100.00



Electricity bill

Bill/Z\$	Actual Values	Percent
0	96	82.05
10	2	1.71
12	1	0.85
20	2	1.71
24	2	1.71
35	1	0.85
36	1	0.85
40	6	5.13
42	1	0.85
56	2	1.71
60	1	0.85
150	1	0.85
300	1	0.85
Total	117	100.00

Paraffin expenditure

Bill/Z\$	Actual Values	Percent
0	61	98.39
1	1	1.61
Total	62	100.00

Complains about present fuel used

Number	Actual Values	Percent
0. Unspecified	1	0.95
1. Expensive	70	66.67
2. No complain	33	31.43
3. Other	1	0.95
Total	105	100.00

Income level

Number	Actual Values	Percent
-3. Unspecified	1	0.82
1. High	6	4.92
2. Medium	55	45.08
3. Low	60	49.18
Total	122	100.00

Food bill

Bill/Z\$/month	Actual Values	Percent
0	7	5.83
50	1	0.83
70	1	0.83
80	1	0.83
100	3	2.50
120	1	0.83
130	1	0.83
150	5	4.17

170	1	0.83
180	1	0.83
200	19	15.83
250	3	2.50
300	10	8.33
350	4	3.33
353	1	0.83
400	14	11.67
450	2	1.67
500	12	10.00
600	8	6.67
700	3	2.50
750	2	1.67
800	2	1.67
900	3	2.50
1000	10	8.33
1200	1	0.83
1300	1	0.83
1500	1	0.83
2000	1	0.83
3500	1	0.83
<b>Total</b>	<b>120</b>	<b>100.00</b>

Transport bill

Bill/Z\$/month	Actual Values	Percent
0	66	54.10
20	1	0.82
28	1	0.82
45	3	2.46
60	1	0.82
63	1	0.82
80	2	1.64
90	1	0.82
100	4	3.28
105	2	1.64
120	2	1.64
130	1	0.82
150	5	4.10
160	2	1.64
180	7	5.74
200	4	3.28
210	2	1.64
220	2	1.64
300	4	3.28
312	1	0.82
330	1	0.82
360	1	0.82
450	1	0.82
540	1	0.82
600	2	1.64

1000	1	0.82
1120	1	0.82
1200	2	1.64
Total	122	100.00

Other expenses

Bill/Z\$/month	Actual Values	Percent
0	77	63.64
15	1	0.83
20	1	0.83
40	1	0.83
50	5	4.13
60	1	0.83
96	1	0.83
100	2	1.65
140	1	0.83
144	1	0.83
150	2	1.65
200	3	2.48
252	1	0.83
260	2	1.65
300	7	5.79
360	1	0.83
500	1	0.83
570	1	0.83
600	3	2.48
700	2	1.65
840	1	0.83

900	3	2.48
1000	1	0.83
1050	1	0.83
Total	121	100.00

Ownership of assets - House

Number	Actual Values	Percent
0	73	60.33
1	45	37.19
2	2	1.65
4	1	0.83
Total	121	100.00

Ownership of a Car

Number	Actual Values	Percent
0	106	86.89
1	15	12.30
5	1	0.82
Total	122	100.00

Ownership of a Bike

Number	Actual Values	Percent
0	101	82.79
1	19	15.57
2	1	0.82
15	1	0.82
Total	122	100.00

### Ownership of Cattle

Number	Actual Values	Percent
0	111	92.50
2	1	0.83
3	1	0.83
4	2	1.67
5	2	1.67
12	2	1.67
56	1	0.83
Total	120	100.00

### Ownership of Hens

Number	Actual Values	Percent
0	99	81.82
1	3	2.48
5	2	1.65
9	1	0.83
10	2	1.65
11	1	0.83
12	1	0.83
23	1	0.83
25	2	1.65
27	1	0.83
30	1	0.83
38	1	0.83
40	1	0.83
50	2	1.65

53	2	1.65
250	1	0.83
Total	121	100.00

Ownership of other Livestock

Number	Actual Values	Percent
0	103	85.12
1	4	3.31
2	3	2.48
3	2	1.65
4	1	0.83
5	1	0.83
6	3	2.48
7	2	1.65
11	1	0.83
16	1	0.83
Total	121	100.00

Person who is responsible for obtaining firewood

	Actual Values	Percent
None users	96	78.33
Head of Household	15	12.5
Child	5	4.27
Worker	4	3.34
Other	1	0.83
Total	1201	100.00



Location of obtaining firewood

Location	Actual Values	Percent
None users	94	78.33
Market	9	7.50
Field or Forest	3	2.50
Neighboring areas	13	10.83
Other	1	0.83
Total	120	100.00

Distance to the source of Firewood

Distance	Actual Values	Percent
< 1km	94	78.33
1 - 5 km	9	7.50
5 - 10 km	13	10.83
> 10 km	4	3.33
Total	120	100.00

Access to the source of firewood

Access	Actual Values	Percent
None users	94	78.33
On foot	15	12.50
Wheel barrow /Bicycle	5	4.17
Public Transport	3	2.50
Other	3	2.50
Total	120	100.00

How long (hrs) is the fire on?

Time	Actual Values	Percent
Unspecified	95	79.17
< 1hr	6	5.00
1 - 2hrs	11	9.17
2 - 3hrs	7	5.83
> 8hrs	1	0.83
Total	120	100.00

For what purpose is Fuelwood burnt?

Purpose	Actual Values	Percent
Cooking	94	78.33
Heating	23	19.17
Lighting	1	0.83
Cooking and Heating	2	1.67
Total	120	100.00

Willingness to Change to Other Source of Energy

Willing	Actual Values	Percent
Yes	92	76.67
No	26	21.67
Other	2	1.67
Total	120	100.00

Type of Energy Which would be preferred

Energy	Actual Values	Percent
Unspecified	94	78.33
Electricity	15	12.50
Kerosene	1	0.83
Other	10	8.83
Total	120	100.00

Willingness to Use Coal Briquette

Willing	Actual Values	Percent
Yes	108	90.00
No	12	10.00
Total	120	100.00

Proposed purpose for Using Coal Briquette

Purpose	Actual Values	Percent
Cooking	13	10.83
Heating	51	42.50
Lighting	3	2.50
Cooking and Heating	53	44.17
Total	120	100.00

Source of Income by House status(Owned/Rented)

Rows: Income, Columns: House status

	1	2	3	Total
0	-	100.00	-	100.00
1	64.20	32.10	3.69	100.00
2	70.00	20.00	10.00	100.00
3	89.66	10.34	-	100.00
Total	70.25	26.45	0.83	100.00

Key.

Income

0 - Unspecified

1 - Salary

2 - Business

3 - Other

Household Status

1 - Owned

2 - Rented

3 - Other

House status by Number of rooms in house

Rows: House status, Columns: Number of rooms

	1	2	3	4	5	6	7	8	9	12	14	17	44	Total
1	21.74	52.63	70.59	88.46	92.31	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	70.49
2	69.57	42.11	23.53	11.54	7.69	-	-	-	-	-	-	-	-	26.23
3	8.70	5.26	5.88	-	-	-	-	-	-	-	-	-	-	3.82
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Key :

Household status

- 1 - Owned
- 2 - Rented
- 3 - Other

House status versus Electrification

Rows: House status, Columns: Electrification status

	1	2	3	Total
1	71.43	73.68	64.86	70.49
2	28.57	22.81	29.73	26.23
3	-	3.50	5.40	2.47
Total	100.00	100.00	100.00	100.00

Key

Rows:

Household Status

- 1 - Owned
- 2 - Rented
- 3 - Other

Columns:

Elect

- 1 - Installed
- 2 - Disconnected
- 3 - Not Installed

Electrification status versus main source of energy for Cooking

Rows: Cooking, Columns: Electrification

	1	2	3	Total
0	-	-	100.00	100.00
	-	-	2.70	0.82
1	20.22	61.80	17.98	100.00
	64.29	69.49	43.24	72.95
2	-	16.67	83.33	100.00
	-	1.75	13.51	4.92
3	40.00	-	60.00	100.00
	35.71	-	40.54	20.49
5	-	100.00	-	100.00
	-	1.75	-	0.82
Total	22.95	46.72	30.33	100.00
	100.00	100.00	100.00	100.00

Key

Rows:

Cooking

- 1 - Wood
- 2 - Electricity
- 3 - Paraffin
- 5 - Other

Columns:

Elect

- 1 - Installed
- 2 - Disconnected
- 3 - Not Installed

Source of energy for lighting versus electrification status

Rows: Lighting, Columns: Elect

	1	2	3	Total
0	-	100.00	-	100.00
	-	5.00	-	0.82
1	89.89	5.62	4.49	100.00
	91.95	25.00	26.67	72.95
2	50.00	-	50.00	100.00
	3.45	-	20.00	4.92
3	12.00	56.00	32.00	100.00
	3.45	70.00	53.33	20.49
5	100.00	-	-	100.00
	1.15	-	-	0.82
Total	71.31	16.39	12.30	100.00
	100.00	100.00	100.00	100.00

Key

Rows:

Lighting

- 1 - Electricity
- 2 - Kerosene
- 3 - Candle
- 5 - Other

Columns:

Elect

- 1 - Installed
- 2 - Disconnected
- 3 - Not Installed

Electrification status versus source of energy for Heating

Rows: Elect, Columns: Heat

	0	1	2	3	4	Total
0	- -	- -	100.00 3.45	- -	- -	100.00 0.88
1	3.66 33.33	21.95 72.00	15.83 44.83	57.32 95.92	1.22 100.00	100.00 72.57
2	40.00 22.22	20.00 4.00	40.00 6.90	- -	- -	100.00 4.42
3	16.67 44.44	25.00 24.00	50.00 41.38	8.33 4.08	- -	100.00 21.24
5	- -	- -	100.00 3.45	- -	- -	100.00 0.88
Total	7.96 100.00	22.12 100.00	25.66 100.00	43.36 100.00	0.88 100.00	100.00 100.00

Key

Rows:

Elect

- 1 - Installed
- 2 - Disconnected
- 3 - Not Installed
- 5 - Other

Columns:

Heat

- 1 - Firewood
- 2 - Kerosene
- 3 - Electricity
- 4 - Not in use



House status versus appliance used for Heating

Rows: House status, Columns: Heat Appliance

	0	1	2	3	11	33	Total
1	10.84 81.82	51.81 71.67	16.87 82.35	20.48 62.96	- -	- -	100.00 70.94
2	6.45 18.18	48.39 25.00	9.68 17.65	32.26 37.04	3.23 100.00	- -	100.00 26.50
3	- -	100.00 1.67	- -	- -	- -	100.00 100.00	100.00 0.85
Total	9.40 100.00	51.28 100.00	14.53 100.00	23.08 100.00	0.85 100.00	0.85 100.00	100.00 100.00

Key

Rows:

Household Status

1 - Owned

2 - Rented

3 - Other

Electrification status versus main source of energy for cooking

Rows: Elect, Columns: Cooking

	Wood	Elect	Paraffin	Total
Unspecified	-	-	2.7	0.82
Installed	64.29	96.49	43.24	72.95
Disconnected	-	1.75	13.51	4.92
Not Installed	38.71	-	40.84	20.49
Other	-	1.75	-	0.82
Total	100.00	100.00	100.00	100.00

Main source of energy for cooking versus main source of energy for lighting

Rows: Cooking, Columns: Lighting

	Elect	Kerosene	Candle	Total
Wood	17.24	45	26.67	22.95
Elect	63.22	10	-	46.72
Paraffin	19.54	45.00	73.33	30.33
Total	100.00	100.00	100.00	100.00

Main source of energy for cooking versus main source of energy for heating

Rows: Cooking, Column: Heat

		Fire	Kerosene	Elect	None	Total
Wood	10	48	17.24	16.33	-	22.81
Elect	50	36	6.9	71.43	100.00	45.61
Paraffin	40	16	75.56	12.24	-	31.51
Total	100.00	100.00	100.00	100.00	100.00	100.00







JICA