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Effect of Load Shedding in Chinhoyi Urban Residential Areas, Zimbabwe

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Abstract This paper presents the findings of the investigation carried out to establish the effects of load shedding in Chinhoyi Residential Urban areas, Zimbabwe. A questionnaire survey to assess the effects and establish the energy pattern and usage of alternative fuels during load shedding was conducted. The survey established that 60% of residence experienced losses in perishable food stuffs due refrigeration failure, 15% reported production downtime in their home industries with 10%having their electrical appliances such as television sets being damaged as a result of the power surges fashioned by the power outage. This has accordingly contributed in thinning the living standards of the residents. The survey also established a peculiar energy pattern and usage of alternative fuels for cooking and lighting during load shedding. Households in the low density areas of Chinhoyi displayed a wide energy matrix of relatively high quality fuels for both cooking and lighting. When compared to households in the high density areas, 55% of the households in low density cook mainly with LPG whereas 93% of households in high density areas cook exclusively with firewood. Use of candles was common for lighting in both residential sectors. Income for the residents was disproportionately eroded as a result of load shedding. The fraction of energy cost to income was found to increase from 16% without load shedding up to 64% for those in the low density and up to 49% for those in the high density areas. This has consequently impoverished the residents. Load shedding was also found to have coined household thieves with 65% of these being women who harvest wood illegally from farms and forests. This form of harvesting is uncontrolled and therefore unsustainable. The survey therefore concludes that women are unduly burdened by the power outage exercise and people in general have been reduced to poverty levels as they are left with dwindled income.

Keywords Load Shedding, Generation Capacity, Fuel Wood, Energy Poverty

1. Introduction

Zimbabwe has two large facilities for the generation of electrical power, the Kariba South Hydropower Station and the Hwange Thermal power Station. The latter is not capable of using its full capacity due to old age and maintenance problems[1]. The generation is undertaken by the Zimbabwe Power Company (ZPC) and the distribution and retail of electricity to the final end user is the business of the Zimbabwe Electricity Transmission and Distribution Company (ZETDC). These companies fall under the Zimbabwe Electricity Supply Authority (ZESA) which is the holding company for both enterprises. The ZETDC is also mandated to assure the nation with security of supplies. In this regard it is the sole buyer of power produced within or outside Zimbabwe. Table1 shows the installed generation capacity of the country.

Of the installed capacity, Zimbabwe has the potential to generate 1870MW against a backdrop of 2500MW peak demand; this gives a deficit of 630MW which it has to meet through imports. There is certainly inadequate power generation capacity in Zimbabwe. Consequently the country imports 35% of its power generation from South Africa's Eskom, Mozambique's Hydroelectrica Cahora Bassa and the Democratic Republic of Congo's Snel[3].

Table 1. Installed Power Generation Capacity for Zimbabwe[2]

Power station	Installed Generation Capacity (MW)
Hwange thermal	920
Harare thermal	50
Bulawayo thermal	80
Munyati thermal	70
Kariba hydropower station	750
Total Generation	1870
Demand	2500

Electricity availability is depressed at the moment and currently Zimbabwe is only generating 805MW[4]. This

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depressed generation is mainly due to a combination of factors, which include among others fuel supply and plant challenges. Three of the small thermal plants; Harare, Bulawayo and Munyati were not generating electricity at the time of writing and generation at Hwange fluctuates due to the obsolete nature of the equipment.

Challenges Related to Electric Power System Maintenance in Zimbabwe

Zimbabwe has been experiencing an economic downturn from around 1999. The decline in economic activity during this troubled period led to problems of power generations in Zimbabwe. The power system has been subjected to inadequate and untimely maintenance which was largely due to lack of foreign currency. Generators are heavily out-running their maintenance cycles. Transformers and switch gear in the transmission and distribution systems are susceptible to catastrophic failures due to lack of prescribed maintenance. Basic maintenance resources are unavailable resulting in poor quality of supply and poor customer service[1]. The electric power system has also faced challenges related to reinforcement and rehabilitation. Most parts of the network are currently operated well above design limits hence supply interruptions risks are high. Many customers are currently being denied access to supply due to insufficient system capacity emanating from lack of adequate system capitalization and the unavailability of materials[1].

The Harare, Bulawayo and Munyati thermal power stations are old; they were built in the late 1940s and refurbished in the mid-1990s[5]. These power stations are too expensive to run and are almost obsolete. They are not generating anything at the moment due to a number of reasons which include shortage of coal to power them. This is despite the country being endowed with vast reserves of high quality coal. The other reason is that the plants are so old and have not been adequately refurbished, hence they will be expensive to run and susceptible to regular breakdowns. The utility company does not have funds to buy coal and transport it all the way from Hwange Colliery as their revenue inflows are too low and, the Hwange Colliery has also failed to provide the company with adequate supplies. On the other hand, the Hwange Thermal Power Station has been inundated by a large number of breakdowns linked to the obsolete nature of machinery in place[5]. The Zimbabwe Electricity Transmission and Distribution Company have thus managed the situation through massive load shedding.

Load shedding is the act or process of disconnecting the electric current on certain lines when the demand becomes greater than the supply[6]. It can also be defined as a rolling blackout which is an intentionally engineered electrical power outage. Rolling blackouts are a last resort measure used by an electric utility company in order to avoid a total blackout of the power system[7]. During periods of blackouts, electricity usage exceeds the available supply; supply is cut in some or all of the high risk zones. These blackouts are normally scheduled at fixed times of the day and week and it may happen without any advance notice to the clients.

This paper broadly examines the energy mix pattern created as a result of loadsheding in Chinhoyi urban residential areas. The survey also aimed at establishing the effects of loadsheding on residents.

2. Methodology

2.1. Description of the Study Area

Chinhoyi city is the provincial capital of Mashonaland West Province in Zimbabwe. The town is approximately 120 kilometers north-west of Harare along the main road to Kariba and Chirundu border with Zambia. The town is situated in a farming area. The population of Chinhoyi according to the 2002 national census was 56 794[8]. Municipality of Chinhoyi services the town which boosts of 8061 residential housing units of which 1195 housing units are located in the low density areas and 6866 in high density areas[9]. The town is electrified and all residential houses are connected to the grid with the exception of the newly acquired housing stands which are still under construction. The town suffers from excessive loadsheding which is negatively affecting energy dependent activities in the town. Chinhoyi experiences the following monthly average weather conditions; highest temperature in October at 31℃, minimum temperature in July at less than 5℃ and average wind speed at 3m/s. January is the wettest month recording 225mm rainfall and July is the driest month with the least precipitation of less than 10mm. Generally the climate is good for Agriculture.

2.2. Survey Design

The Household Energy Survey was carried out in the city of Chinhoyi between February and April 2010 using stratified sampling. The methodology consisted of a household survey in which a questionnaire was distributed to respondents. The household was used as the enumeration unit because it is the basic consumption unit from which meaningful inferences on the energy matrix and use can be made.

The survey was designed to investigate energy types and usage by Chinhoyi urban dwellers as alternatives to electricity during loadsheding, and to determine the effects of loadsheding on the urban dwellers. The study surveyed the pattern in the consumption of firewood, LPG, kerosene, diesel/petrol, candles and other fuel sources as alternatives to electricity use. The households were asked how much of each were consumed on a monthly basis and the financial implications of it deduced. The demographics of the survey concentrated on the high density and low density residential areas of Chinhoyi urban.

2.3. Data Collection

Samples of 5% of the total housing units were used in both the low and high density residential areas. Homogeneous geographical clusters were randomly selected within each location of the high and low density neighborhood. Within each cluster, the housing units were selected at random, through a clustering point and a sampling interval designed to exhaust the sample.

Undergraduate students in the department of Fuels and Energy at Chinhoyi University assisted as enumerators in this study. The students were appraised in administering the questionnaires. Each student undertook to survey twenty households (20 students and 403 households).

2.4. Data Analysis

The findings of the household energy survey were analyzed with reference to the following aspects:-

(a) the salient features of household energy consumption patterns in the selected areas

(b) fuel-specific consumption patterns cross-referenced to geographical areas by status of linkage to income;

(c) Energy management practices vis-a-vis the types of stoves used; and

(d) Specific conditions relating to the social effects of load shedding

3. Results and Discussions

3.1. Bio-data and Demographic Information

70 % of the respondents found in the homes were female adults and 30 % were male adults. Of the respondents in the high density suburbs 33 % of them were gainfully employed with an average monthly income of less than US $150.00, 21 % were self employed barely making an income of $200.00 per month and 46 % were not employed but occasionally getting income from casual labour.

For the low density suburbs, 70 % of the respondents were gainfully employed with an average income above $250.00 per month. 20 % were self employed also barely making an income of US$200.00 per month and 7% were unemployed but relied on income from children or relative in the diasporas with 3% unemployed and sporadically getting income through casual work.

In the high density suburbs, the median number of people per household was a little over 6, with nearly 30 % of the households having 8 or more inhabitants and 5 % had 10 or more and the maximum recorded was 13 members in a single household. Whereas in the low density suburbs, the median number of people per household was 4, with nearly 20 % of the households having 6 or more inhabitants and the maximum recorded were 8 members.

3.2. Profile of Load Shedding in the High Density and Low Density Suburbs of Chinhoyi Urban Community

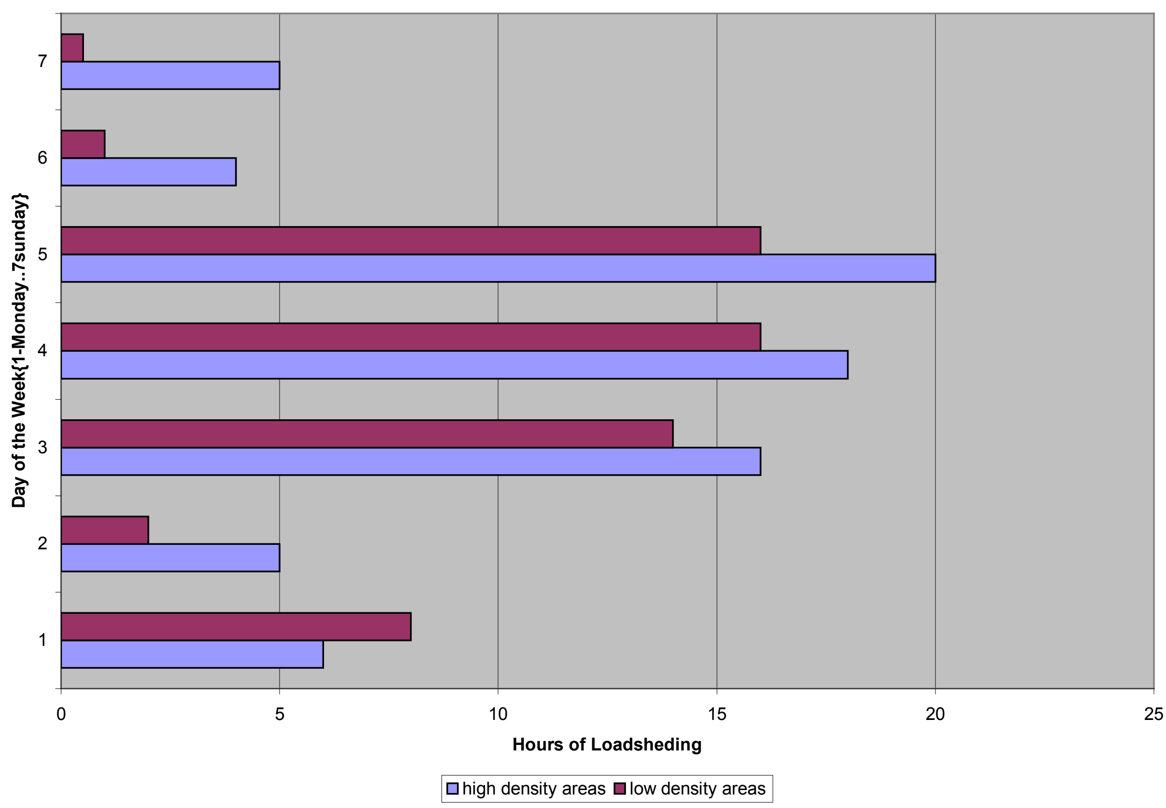

Figure 1. Load shedding profile for Chinhoyi residential areas

The hours of load shedding experienced by both the low and high density suburbs of Chinhoyi as reported by the respondents is as shown in figure 1 above. The power outages occur from 1600 hours on Mondays, Tuesdays, Saturdays and Sundays for cumulative time of 21 hours for high density suburbs and 13 hours for low density. On and Wednesdays, Thursdays and Fridays it has been observed that residents are switched off at 0500 hours for cumulative times of 54 hours and 46 hours for the high density and low density areas respectively. On average the low density residential areas experience 59 hours of load shedding per week; whereas those in the high density areas experience 75 hours of load shedding per week. There seems to be a variance in the dark hours experienced by the residence in these two residential sectors. Residents in the low density areas seem to be enjoying less load shedding in terms of the total hours of darkness compared to residents in the high density areas. There is therefore preferential treatment accorded to the different residential areas.

3.3. Direct Observable Effects of Load Shedding to Chinhoyi Urban Dwellers

Residents of Chinhoyi urban, in both the low and high density areas indicated that the load shedding is random; the power provider seemed not to follow a fixed time. When the electricity is switched off there are some on and off fluctuations of power surges experienced and the same fluctuations are experienced during switching on of residents. These fluctuations together with the excessive long hours of power outages have caused undesirable effects to the residents. Table 2 shows a summary of the responses to the losses incurred by households in Chinhoyi as a result of the intermittent load shedding programme.

Table 2. Summary of damages or losses incurred by household in Chinhoyi residential urban areas

Frequency of the respondents	Description of the Damage/Loss incurred
60%	loss of perishable food stuffs due refrigeration failure
10%	claim to have had damages done to their television sets
6%	had compressors of refrigerators damaged
20%	reported to be replacing at least two blown out incandescent lamps weekly
4%	had radios damaged
10%	were deprived of opportunity to attend adult night school(literacy training)
15%	Reported loss of production time in their home industries. Consequently, they failed to meet their production targets leading to loss of revenue and possible markets.

There could be many more losses which might not have been captured in this survey. All these losses have a financial bearing on the victims who might have to incur extra costs in repairing the damaged gadgets or to replace it with a new one. Property gathered in the African setting connotes the wealth status of a person, now when the same property is damaged it implies a reduction in one's status. In a way loadsheding can be said to be further diminishing the living standards of people of Chinhoyi urban if it goes beyond damaging one's hard-won fruits.

3.4. Fuel Substitution for Cooking

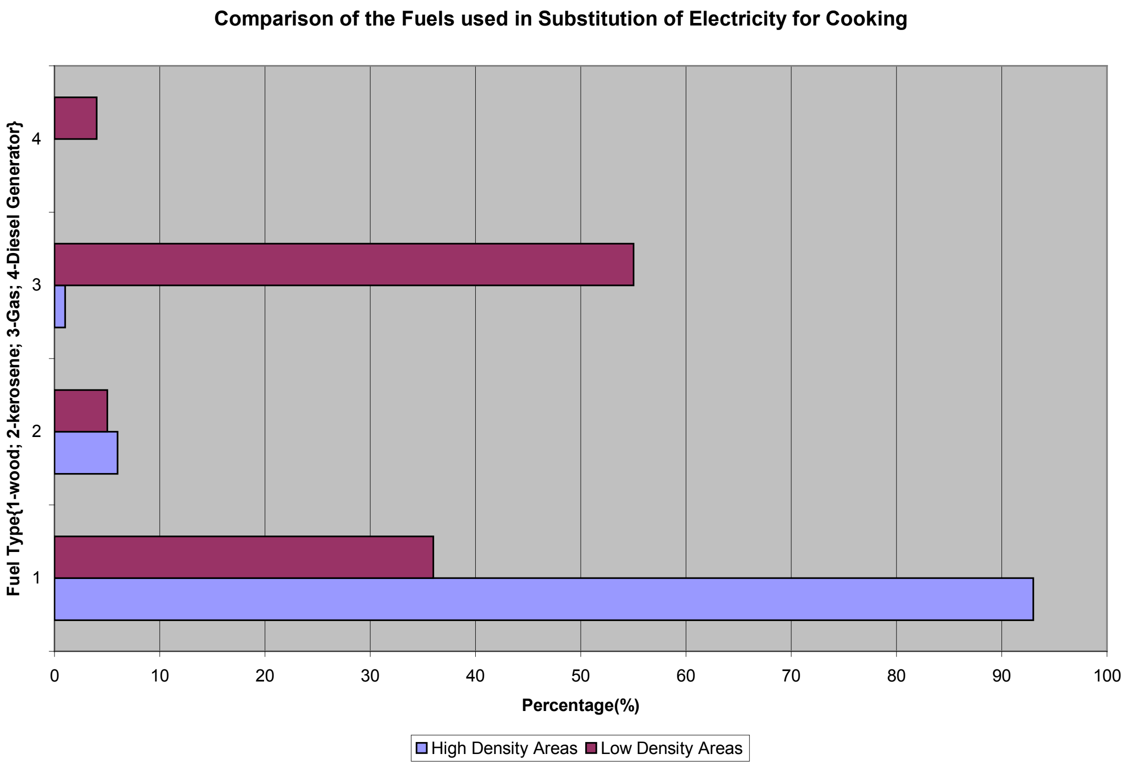

Figure 2. Comparison of fuels used in substitution of electricity for cooking

Figure 2 shows a comparison of the households employing various fuel types for cooking in the low and high density areas of Chinhoyi Urban community.

In the low density suburbs of Chinhoyi, the majority of households (55%) cook mainly with gas while about 36% use mostly wood for cooking during power outages. Only 4% use diesel generators for cooking purposes and 5% resort to the use kerosene. Fuel substitution for cooking in the low density suburbs therefore mainly occurs between gas and wood with gas having a larger proportion of the share.

In the high density suburbs, firewood is the main cooking fuel, used by about 93% of the households. At the same time, almost 6% of the households use kerosene fuel and only 1% use gas for cooking purposes, no diesel or petrol generators are used for this purpose. Therefore fuel substitution for cooking in the high density suburbs was found to be mainly wood.

The quantities of wood used in the respective suburbs were found to be 310kg / month per household (10kg/day) for residence in the high density suburbs and for low density residence the average wood consumption per month per household was found to be 143kg / month (4.6kg/day).

There is an apparent anomaly which should be noted, in the comparison of the firewood consumption for the households in the low density and high density suburbs of Chinhoyi. The average monthly firewood consumption in high density suburbs for house hold cooking is more than double the amount that of low density suburbs. Possible explanations for the discrepancy might include:

- under reporting of fuel wood consumption in low density areas
- differences in the dietary and cooking habits in the respective areas
- wood conservation techniques employed by the different households
- fuel price differentials in the two areas- the price of wood pegged in low density areas is slightly higher than that in the high density areas. People in the low density areas of Chinhoyi professed that they buy all their fuel wood requirements from fuel wood vendors who move door-to-door selling the commodity. A bundle of fuel wood typically weighing approximately 25 kg costs $4.00 in the low density areas. Whereas 55 % of the respondents who use fuel wood in the high density areas indicated that they buy their fuel wood from wood vendors at illegal selling points. A bundle of fuel wood (25 kg in mass) cost $3.00. This therefore points to the fact that residence in the high density areas tend to enjoy an abundance of the commodity at a cheaper price.
- Large family size in the high density areas leading to higher levels of wood consumption
- Differences in the moisture content of the wood used in the two areas.
- Most households in the high density areas (45%) gather their own wood from the near by farm at zero financial costs- hence the seemingly extravagant use of the commodity.

The rate at which the wood is being used has significant impacts on the health of urban dwellers. The fire wood is generally used in open hearths or simple stoves that are inefficient and polluting. Combustion of the wood biomass emits pollutants that currently cause more than 1.6 million deaths globally each year (400 000 in Sub-Saharan Africa alone), mostly among children and women[10]. More than a dozen studies around the world have found that household use of solid fuels is associated with acute respiratory infection in young children. Tuberculosis has also been associated with the household use of wood, as well as the chronic respiratory diseases such as chronic bronchitis; which has been found to develop in women after long years of exposure to the pollutants[10]. The effect of these pollutants might not be felt now, but in the short near future the Government of Zimbabwe shall be forced to invest heavily on the medicinal cure of these respiratory diseases, also quite a good number of workforce particularly those exposed to the pollutants shall be victims of death.

3.5. Fuel Substitution for Lighting

Figure 3 shows a comparison of the households employing various fuel types for lighting in the low and high density areas of Chinhoyi Urban community.

In the high density suburbs; it ca be noted that 72.8 % of the residents use candles only for lighting; 18 % use kerosene lamps only; 3% use rechargeable lamps only; 4% use a combination of rechargeable lamps and candles; with only 0.9% using diesel generator sets for lighting and powering of other electric appliances such as TV and radios. It was surprising to note that 1.3% of the respondents do not use any form of lighting during load shedding; they remain in darkness until the load shedding is lifted. The reason for not using any form of lighting was cited as being lack of money to buy the fuels for lighting.

In the low density suburbs; 30% of the residents use diesel generator sets for lighting and powering of other electric appliances such as TV and radios. 60% use candles for lighting only; and 10% use a combination of candles and rechargeable lamps

The average consumption of candles on monthly basis was found to be 4 packets, each of 6 candles (i.e. 24 candle sticks) for the high density suburbs and for the low density suburbs the average candle consumption was 6 packets per month. This discrepancy can be explained by the lighting requirements of the households, also, the size of the rooms differ for different localities. In low density areas, the rooms are much bigger compared to those in the high density areas, this therefore means more light needed hence more candles consumed.

Households using a combination of both candles and rechargeable lamps required on average 2 packets of candles per month.

Households using single phase power diesel generators tended to use on average 40 liters of diesel per month for both lighting and powering of other electrical appliances, and households using kerosene for lighting only used 3 liters per month.

A major concern is the effect of diesel exhaust which have been linked in numerous scientific studies to cancer, the exacerbation of asthma and other respiratory diseases[15]. Diesel exhaust has been found to contain nanoparticles which have been associated with damage to the cardiovascular system[11]. A draft report released by the EPA in February 1998 indicated that exposure to even low levels of diesel exhaust is likely to pose a risk of lung cancer and respiratory impairment[12]. The health risks from diesel exposure are greatest for children, the elderly, and people with respiratory problems and people who work or live near diesel exhaust sources. This implies that people who use diesel generators in their homes are at very high risk. Whereas people in the high density areas are at risk of smoke from burning firewood, those in the low density areas are at risk from diesel engine fumes.

3.6. Financial Implications

Table 3 shows the spread sheets for the average energy matrix expenses incurred by residence in the high and low density areas respectively. The different categories are compared. However, it must be noted that the average billing estimates used by ZESA for household use of electricity is 450kWh at a unit price of US$0.07/kWh. This quantity is equivalent to US$31.50 which must be paid to ZESA by each household. Table 3 must therefore be read with this baseline in mind.

The following categories as shown in table 3 are herein defined:

- Category AL & AH denotes households in low and high density areas respectively who cook exclusively with wood and use candles only for lighting.
- BL & BH- households in low and high density areas respectively that cook almost exclusively with wood and use a combination of candles and rechargeable lamps for lighting.
- CL & CH- households in low and high density areas respectively that use LPG for cooking and candles only for lighting.
- DL & DH- households in low and high density areas respectively that cook exclusively with wood and use diesel generators for lighting.
- EL & EH- households that use exclusively diesel generators for both cooking and lighting.
- FL & FH- households that use kerosene exclusively for both cooking and lighting.

The quantity (2 - 6) for candles in the table3; for example denotes that the least quantity of candles used per month was 2 packets and the maximum number used was 6 packets @ a price of $2.00 per packet. The fuel cost is thus calculated from (Unit price X Quantity of fuel consumed per month).

The category AL which shows the costs incurred by the residence that cook exclusively with wood and use candles only for lighting in the low density areas, when compared with their counterparts AH in the high density areas, shows that those in category AL pay less for their energy provisions by 13.2%.

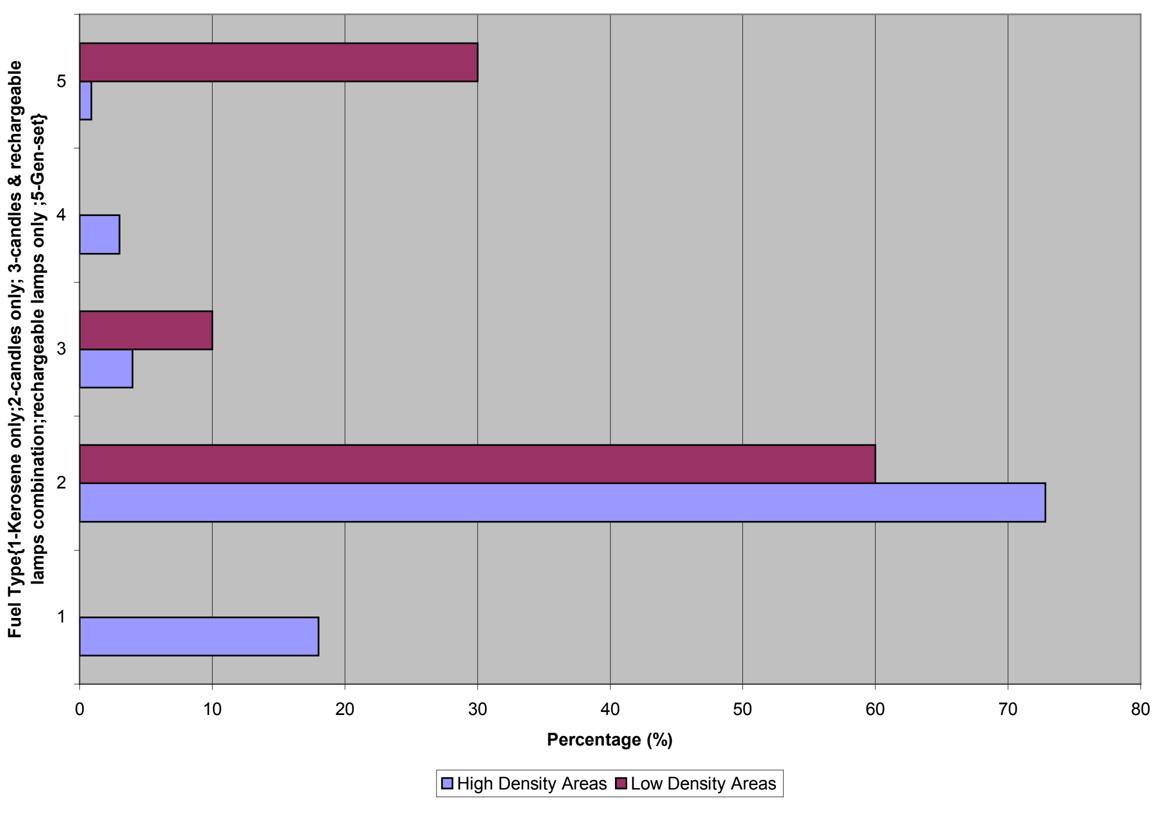

Figure 3. Comparison of fuel type used in substitution of electricity for lighting

Table 3. Average Anticipated Monthly Costs on Energy Consumptions for different categories of consumers in Chinhoyi

			Fuel costs (US$)for the different energy consumption patterns						
HIGH DENSITY									
Fuel type	**unit price$**	**quantity**	**AH**	**BH**	**CH**	**DH**	**EH**	**FH**	**GH**
candles	2	2 - 6	8	4	12	0	0	0	0
kerosene	0.8	3 - 15L	0	0	0	0	2.4	12	0
wood	0.12	310kg	37.2	37.2	0	37.2	37.2	0	37.2
diesel	1.08	40 - 100L	0	0	0	43.2	0	0	0
LPG	2.17	6kg	0	0	13	0	0	0	0
electricity	0.07/kWh	249kWh	17.44	17.44	17.44	17.44	17.44	17.44	17.44
TOTAL $			**62.64**	**58.64**	**42..44**	**97.84**	**57.04**	**29.44**	**54.64**

LOW DENSITY									
Fuel type	**unit price$**	**quantity**	**AL**	**BL**	**CL**	**DL**	**EL**	**FL**	**GL**
candles	2	2 - 6	12	4	12	0	0	-	-
Kerosene(l)	0.8	3 - 15L	0	0	0	0	0	-	-
Wood(kg)	0.16	143kg	22.88	22.88	0	22.88	0	-	-
Diesel (l)	1.08	40 - 100	0	0	0	43.2	108	-	-
LPG (kg)	2.17	6kg	0	0	13	0	0	-	-
electricity	0.07/kWh	291.96kWh	20.44	20.44	20.44	20.44	20.44	-	-
TOTAL $			**55.32**	**47.32**	**45.44**	**86.52**	**128.44**	**-**	**-**

Category BL in the low density areas shows costs incurred by residence that cook almost exclusively with firewood and use a combination of candles and rechargeable lamps for lighting. Their counterparts BH in the high density areas seem to pay more for the similar energy provisions by 19.3%.

Both the CL and CH categories in the low and high density areas respectively displayed the same expenditure pattern as they both use equally the same quantities of LPG for cooking and candles for lighting. In the low density areas, energy consumption pattern CL was the cheapest option in use by residence in this sector.

Category DL for the low density areas shows those households that cook exclusively with wood and use diesel generator sets for provision of lighting and power for other electrical appliances. Similar counterparts DH in the high density areas have an extra cost of 11.6% more than DL.

Category EL for low density residence shows an energy consumption pattern that restricts itself to the use of diesel generator set for all power applications in substitution for load shedding. It is the most expensive energy matrix used in the low density areas, and in high density areas matrix EL is non existent. However high density areas also displayed energy consumptions patterns which were evidently non-existent in low density areas. EH for instance use kerosene for lighting and wood for cooking, this is not evident in the low density suburbs. On the other hand residences in FH category use kerosene exclusively as a fuel substitute for lighting and cooking. This option was identified as the cheapest energy matrix in use by residence in high density areas. In category GH the residences use wood for cooking and they cannot afford any form of lighting in the home during evenings of load shedding. Though they deprive themselves of lighting, it is surprising to note that they pay 85.6% more for their fuel requirements than residences in category FH who have the cheapest and better fuel option than them. The most likely reason for lack of lighting is that they residence might not have any form of income and the firewood which they use is collected for free at the expense of the environment. So they might not have any financial penalty on their choice of energy matrix.

Residents in the low density suburbs of Chinhoyi tend to use modern alternative energy sources for both cooking and lighting than the residents in the high density suburbs. This can be explained by the different income levels for the two sectors.

3.7. Energy Consumption Pattern Vs Disposable Income

Demographic information revealed that the average monthly income levels for residents in the high density suburbs of Chinhoyi was below US$150.00 for 33 % of the residents who were gainfully employed, and 21 % who were self employed barely got US$200.00 per month, and 46 % indicated that they were not employed and hence relied mostly on casual labor opportunities.

For the low density suburbs the income levels were found to be above US$250.00 for 70% of the respondents, with 20 % being self employed and getting a monthly income of US$200.00.

Table 4. Net disposal income as determined by the energy consumption patterns

Energy consumption pattern	Total fuel costs ($)	Net disposable income* from earnings of:-			Average % depletion of income by energy costs with load shedding	Average % depletion of income by energy costs without load shedding
		$150	$200	$250		
AL	55.32	$ 94.68	$145	$195	**28%**	**16%**
BL	47.32	$ 102.68	$153	$203	**24%**	**16%**
CL	45.44	$ 104.56	$155	$205	**23%**	**16%**
DL	86.52	$ 63.48	$113	$163	**43%**	**16%**
EL	128.44	$ 21.56	$72	$122	**64%**	**16%**
AH	62.64	$ 87.36	$137	$187	**31%**	**16%**
BH	58.64	$ 91.36	$141	$191	**29%**	**16%**
CH	42.44	$ 107.56	$158	$208	**21%**	**16%**
DH	97.84	$ 52.16	$102	$152	**49%**	**16%**
EH	57.04	$ 92.96	$143	$193	**29%**	**16%**
FH	29.44	$ 120.56	$171	$221	**15%**	**16%**
GH	54.64	$ 95.36	$145	$195	**27%**	**16%**

*The net disposable income is the difference between one's earning (i.e. total income) and the total fuel costs.

Table 4 shows the disposable income as determined by the energy consumption patterns of the residences in the low and high density suburbs of Chinhoyi. Depending on the energy consumption pattern, the fraction of energy cost to income increased from 16% when the costs are calculated without load shedding up to 64% for residence in the low density areas. For those in the high density areas the energy costs increased from 16% up to 49%. The income depletion in the high density areas is at the expense of the environment, because this is the group that prevalently uses firewood as fuel substitute destroying forests. On the other hand the residence from the low density area pay a heavy cost for their affluence and so both groups are affected.

It appears that the energy consumption patterns of residents in the high density areas tend to add to their misery and aggravate their poverty. They pay more for daily energy needs; they are less likely to accumulate the wealth needed to make the investments that are necessary to make use of cheaper and more efficient fuels and appliances as depicted by energy consumption pattern CL. Given the levels of income it is quite clear that load shedding has in a way managed to impoverish the residents of Chinhoyi urban. The little income earned or generated is all wiped away in a bid to secure alternative energy to electricity. Load shedding has thus impacted negatively on the well-being of the urban residents of Chinhoyi; people have been reduced to poverty levels through poor choice of alternative energy options.

3.8. Procurement of Wood

People in the low density areas of Chinhoyi and 55% of those from high density areas professed that they buy all their fuel wood requirements from fuel wood vendors who move door-to-door selling the commodity and at illegal selling points. However, 45 % of the respondents in high density areas indicated that they collect their own fuel wood from the near-by farms and forests. Collection of the fuel wood is usually done early in the morning around 0300 hours, for fear of the law enforcing agents. In other words the fuel wood is stolen and distances covered in transporting the fuel wood from these sites was found to be in the range of 5km to 15km depending on the location.

65 % of those who collect their own fuel wood for household consumption were women and only 35% were man. Male fuel wood gatherers indicated that they use men drawn push carts in ferrying the fuel wood, while women carry their bundles of fuel wood by head.

Load shedding has thus coined household thieves who poach fuel wood from nearby farms and forests. This form of fuel wood harvesting is uncontrolled and therefore unsustainable, and if allowed to continue then satisfying future demand in urban settings might pose major environmental problems. Also, it has led to a massive harvesting of fuel wood by fuel wood traders and urban residents who have found a market in the energy starved residence of Chinhoyi. This is a threat to the extinction of flora and fauna leading consequently to environmental degradation.

Women are unduly burdened by the power outage exercise. More women in Chinhoyi urban are involved in fuel wood collection than man. They spend hours gathering fuel wood in nearby farms and forests facing possible threats of sexual harassment in these isolated areas. They also suffer from the physical drudgery of carrying the rough heavy fuel wood bundles on their heads.

3.9. Energy and Fuel Management

Households in both the low and high density residential areas of Chinhoyi tended to use several types of inefficient stoves particularly with fuel wood. 60% of the residents, who used fuel wood in Chinhoyi as fuel substitute to electricity, employed the use of three-stone stove when cooking. 30 % of the residents used unshielded four-legged metal grates which were more of stands for cooking pots than energy saving technologies and 10% used braai stands as stoves for cooking purposes.

For the households cooking with fuel wood, 90 % did outdoor cooking; of this fraction 60 % of them do their cooking on open air adjacent to the wall of a building and 40 % had some form of roofed shelters which provided some wind break on the sides. 10 % did in-door cooking with fuel wood using the in-built fire hearth in kitchens.

The results indicate that there is a lot of energy wastage from the types of stoves used. The stoves used are inefficient, and they are open to the air which carries away useful energy, hence resulting in consumption of more fuel. The setup is not fuel conservative. More so, use of fuel wood on the other hand was found to compromise the health of household members, especially when it is burned indoors without either a proper stove to help control the generation of smoke or a chimney to draw the smoke outside. Thus in addition to its relatively high cost, the use of fuel wood may promote higher medical care expenditures and diminish the poor's ability to work productively. This is a clear indication that there is need for energy management and efficient utilization of energy education for people in Chinhoyi urban.

3.10. Poverty- loadsheding Nexus

The energy dimension of poverty; energy poverty may be defined as the inability to cook with modern cooking fuels and the lack of a bare minimum of electric lighting to read or for other household and productive activities at sunset[13]. Load shedding in a way denies people of the reliable high quality energy services. Urban dwellers are left with very limited choice of affordable alternative fuels. This lack of adequate energy inputs can be a severe constraint on the economic and social development of people. People have been unable to carry-on with the activities of their backyard industries which depend solely on electricity; this has deprived many of their livelihoods. Some have been deprived of an opportunity to embark on adult evening education classes. This has a consequent effect of impoverishing people through the perpetuation of illiteracy.

Analysis of the energy consumption patterns revealed the discrepancies associated with energy consumption costs for residence in the low and high density areas. The poor pay more money, or spend more time for energy services, than those who are better off[13]. This has a powerful implication. The economic hardship endured by poor households is inconspicuous when their income is evaluated in terms of its command over the basket of goods and services purchased by households with average income or consumption expenditures. When a greater portion of this income goes towards securing alternative energy and fuels, this implies that the vicious cycle of poverty is being catalyzed by load shedding management strategy of the utility company.

4. Conclusions

In light of the findings from this survey, it can be concluded that load shedding has extended the dimension of energy poverty into the urban areas. People particularly those in the high density areas have been found to rely more on the use of less efficient traditional fuels and inefficient stoves which proved to be expensive and add misery to their lives. Consequently the income for residents in the high density areas is disproportionately eroded through poor choice of fuel alternatives compared to residents in the low density areas.

Load shedding has also managed to impoverish the urban residents through losses incurred in the form of decayed food stuffs as a result of fridge failures, and damages to electrical appliances due to voltage fluctuations fashioned by the power outages. Some residents have also been deprived of opportunities for continued education through evening classes which could not take off for power failure. This consequently has an effect of perpetuating the poverty cycle which can be easily driven out through education. A number of enterprising urban dwellers that generate revenue from their backyard home industries which require the service of electricity are being starved of the prospect. The end result is further thinning of the living standards of Chinhoyi urban residents.

Load shedding on the other hand has coerced women in particular to poach fuel wood from nearby farms and forests. This has also led to a massive harvesting of fuel wood by wood fuel traders who have found a ready market for the commodity in urban residential areas. This form of fuel wood harvesting is uncontrolled and therefore unsustainable and, if allowed to continue, is a threat to the extinction of flora and fauna leading consequently to environmental degradation. More women than men in Chinhoyi urban are involved in fuel wood collection, thus women have been found to be unduly burdened by the power outage exercise as they spend hours gathering fuel wood in nearby farms and forests. In such secluded places, they face possible threats of sexual harassment. They also suffer from the physical drudgery of carrying the rough heavy fuel wood bundles on their heads. Load shedding has thus brought untold suffering to the residents of Chinhoyi urban.

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