

# Socioeconomic factors associated with the use of clean energy for cooking in informal settlements of Kigali City, Rwanda

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**Abstract**— Energy plays a vital role in human life as it serves in many different activities such as heating, cooking, transportation and lighting etc. This research aimed to determine household's socio-economic factors associated with energy choice in informal settlements of Kigali city, Rwanda. The research was conducted in three sectors namely Gatenga located in Kicukiro district, Kimisagara located in Nyarugenge district and Kimironko in Gasabo district. Cluster sampling technique has been adopted to categorize the study area into different residential zones on the basis of socio-economic status where a sample of 107 participated in the research.

Chi-square test and Cramer's *V* statistics was used to test the correlation between the household's socio-economic factors and choice of energy. The research findings confirmed that most dominant energy type used for cooking in the study area is charcoal which is non-clean energy. Also, family size and monthly income of the household influenced the choice of energy type used for cooking in informal settlement of Kigali City.

**Keywords**— Socio-economic factors, clean energy, informal settlements.

## I. INTRODUCTION

Globally 2.5 Million people depend on biomass such as agriculture waste, fuel wood, charcoal and animal dung to meet their energy needs, these resources account for 90% of energy consumption in many developing countries ( Kanagawa and Nakata, 2007). In developing countries 52% of the population depends on biomass as a primary fuel for cooking, this proportion of population depending on biomass is highest in sub-Saharan Africa (IEA, 2006).

In east Africa countries, energy is typified by high levels of reliance on biomass coupled with low levels of electricity consumption. Charcoal and bio-fuels/waste, a classification that encompasses traditional biomass like wood and crop residues for cooking and heating, is the source of 65% of the total final energy consumption in Kenya and 93% in Burundi (EACREE, 2018).

According to the Rwanda Energy Policy and Strategy of 2011, biomass dominate energy usage with the rate of 85% which coming from directly used wood (57%), wood converted into charcoal (23%) and crop waste and other agriculture residue with rate of 5% (NISR, 2012). Firewood is still the source of fuel used for cooking by the vast majority of the rural population at the rate of 93% in 2017. In the urban areas, charcoal is used by 65% of households, followed by firewood 26%. While rural households have not changed the source of fuels they used for cooking in the last three years, a small change can be observed in the urban areas shifting from firewood 29% to 26% and charcoal 68% to 65% towards gas use 1% to 5% in 2014 and 2017 respectively (EICV5, 2018).

The research intended to assess socioeconomic factors associated with the use of clean energy for cooking in informal settlement of Kigali City and specifically undertaken with the following objectives:

- To evaluate different types of clean energy used for cooking in informal settlement of Kigali city
- To find out socioeconomic factors that influence the selection of used energy for cooking in informal settlement of Kigali city.

This research project was carried out in three districts of the City of Kigali namely Kicukiro, Gasabo and Nyarugenge especially some villages with informal settlement. The study area was selected based population density. The area in which the study was conducted are Gashyekero located in Gatenga sector of Kicukiro District, Rukurazo located in Kimironko sector of Gasabo District and Amahumbezi located in Kimisagara Sector of Nyarugenge District. This research was carried

out within a period of seven months period from June to December 2019 which includes data collection, data analysis, report writing and presentation of research findings.

## II. MATERIALS AND METHODS

### 2.1 Study Population

This research was conducted in three sectors of Kigali, one in each district based on population density per sector and the most densely populated sector of each District will be selected. As each sector of Kigali city present a number of households living in urban conditions and other part of households living in settlement, study population was selected based on inhabitants per square meter of sector but sample was selected in cells which present the highest informal settlement within the study population.

The research population is 1647 households distributed in Rukurazo inhabited by 496 households, Amahumbezi inhabited by 538 households and Gashyekero inhabited by 613. Generally, the study area represents the most densely populated sector in each District.

### 2.2 Sample size

A sample of household was selected within study population and the sample size was calculated based on the number of households present in each of three settlements which constitute the study population. Number of households interviewed was selected randomly within strata. The sample size was determined by Nassiuma formula (Nassiuma, 2000);

$$\text{Sample size (n)} = (NCv^2) / [Cv^2 + (N-1) e^2] \quad (1)$$

Where:

N = Number of population

CV = Coefficient of Variation (0.5)

e = Tolerance at desired level of confidence (0.05) at 95% confidence level

Therefore,  $n = 1647 (0.5^2) / [0.5^2 + (1646) 0.05^2] = 107.3 \sim 108$

By applying Nassiuma formula and contingency, the sample size of this research was equal to 108 households of three informal settlements Kigali city where 32 households was selected in Rukurazo settlement of Kimironko sector 40 was selected in Gashyekero settlement of Gatenga Sector and 36 households was selected in Amahumbezi settlement located in Kimisagara sector.

### 2.3 Data collection and analysis

All data collected from the field were transcribed by converting all data into textual form. Quantitative data from the questionnaires and the interview checklist checked for data integrity, completeness and consistency before entry and subsequent analysis then entered in SPSS (Statistical package for Social Sciences) 16.0 for analysis. Analysis of chi-square test and p value as a statistical technique were calculated to show difference between two or more variables to test the significance. The chi square test was performed by comparing two types of variables and as well as the variation within each of the samples.

## III. RESULTS AND DISCUSSIONS

### 3.1 Summary of findings from the research

The table 1 show that the research was conducted in households headed by medium generation ranged between 36-45 years old at the rate of 34.6%. In terms of marital status, 69.2% of visited households were married and only 1.9% were divorced. Also, the research found that 55.1% of visited households composed by 3 to 5 persons and only 1.9% of visited households composed by more than 8 members. The research found that 40.2% of visited households earn less than 50,000 FRW per month and only 0.9% earn more than 200,000 FRW per month. Results from this research confirm that most of households live in informal settlements are generally poor.

**TABLE 1**  
**SUMMARY OF FINDINGS FROM THE RESEARCH**

Item	Data					
Age	Class (years)	25-35	36-45	46-55	56-65	Above 65
	Result (%)	17.8	34.6	29.9	11.2	6.5
Marital Status	Category	Single	Married	Divorced	Widowed	Separated
	Result (%)	5.6	69.2	1.9	17.8	5.6
Size of HH	Class (#)	Less than 3	3-5	6-8	More than 8	
	Result (%)	15.9	55.1	27.1	1.9	
HH Monthly income	Class (FRW)	Less than 50,000	50,001-100,000	100,001-200,000	Above 200,000	
	Result (%)	40, 2	31,8	27.1	0.9	

### 3.2 Energy types used in informal settlements of Kigali City

The type of energy used for cooking in the studies areas are firewood, charcoal and gas where charcoal was dominant energy with 77.6% followed by gas with 20.6% while very few of the respondents used firewood with 1.9% as indicated by figure1. Among the respondents, no household found using solar, biogas and electricity as the household income for the studied areas cannot afford their cost. These research findings are similar to the Ndolo's findings, where they have found that most of cooking energy used was charcoal in Gatwekera of Kibera, Nairobi City of Kenya(Ndolo, 2014).

**TABLE 2**  
**TYPE OF ENERGY USE FOR COOKING**

Type of Energy for cooking	Frequency	Percent
Firewood	2	1.9
Charcoal	83	77.6
Gas	22	20.6
Total	107	100.0

### 3.3 Social Economic factors influence the use of Energy for Cooking

#### 3.3.1 Factor 1: The size of family Vs type of energy use for cooking

The research resulted that LPG which is clean is using by family composed by less than 6 members. This confirm that the size of family influence the choice of energy use for cooking. These research findings are similar to the Ndolo's findings, where they have found that, size of the households is one of social factors that influence the choice of cooking energy type (Ndolo, 2014).

**TABLE 3**  
**THE SIZE OF FAMILY VS TYPE OF ENERGY USE FOR COOKING**

Type of Energy	Size of Family	Firewood		Charcoal		Gas	
		Count	Percent	Count	Percent	Count	Percent
	Less than 3 people	2	100	8	9.7	7	31.8
	Between 3 to 5 people	0	0	44	53	15	68.2
	Between 6 to 8 people	0	0	29	34.9	0	0
	More than 8 people	0	0	2	2.4	0	0
Total		2	100	83	100	22	100

#### 3.3.2 Factor 2: Monthly income of the household Vs type of energy use for cooking

The survey showed that a big number of households that use charcoal as cooking energy are those who earn the monthly income up to 200,000 FRW. Firewood is used in the families earning monthly income less than 100,000 FRW while gas is only used by the families earning monthly income more than 100,000 FRW.

The selection of energy type for cooking depends on monthly income due to other factors related to the required infrastructure, equipment and materials. Many households choose charcoal (77.6%) for cooking as it does not require appropriate infrastructure and specified equipment and materials compared to the requirements needed for clean energy use. The initial cost for gas is higher compared to the firewood and charcoal ones. The families earning monthly income less than 100,000 Rwandan francs are not able to afford the initial cost of clean energy. These have also been found in Kenya by Ndolo and Nyankone and Waithera where the researchers found that the household income generation, cost of energy and monthly expenses contribute to the choice of cooking energy type (Ndolo, 2014) and (Nyankone and Waithera, 2016). This research findings showed that households which earn monthly income more than 100,000 Rwandan Francs can easily afford gas compared with what Ndolo found in Kibera which is around 15,000 Kenyan shillings monthly income.

**TABLE 4**  
**MONTHLY INCOME OF THE HOUSEHOLD VS TYPE OF ENERGY USE FOR COOKING**

Type of Energy		Firewood		Charcoal		Gas	
		Count	Percent	Count	Percent	Count	Percent
Monthly Income (FRW)	Less than 50,000	1	50	42	50.6	0	0
	Between 50,001-100,000	1	50	33	39.7	0	0
	Between 100,001-200,000	0	0	8	9.7	21	95.4
	Between 200,001-300,000	0	0	0	0	1	4.6
Total		2	100	83	100	22	100

### 3.3.3 Factor 3: Monthly cost for cooking energy

The research shows that the family with high income has a choice of different energy type which includes clean energy. It was resulted that charcoal is more expensive than LPG but visited households confirmed that initial cost for LPG infrastructure limit them to use clean energy for cooking. These results showed the similarity with Kiyawa and Yakubu which confirm that the choice of energy was influenced by the household's income and the family size where families with large size and those with low income tend to use charcoal which is none clean energy for cooking and the families with small size tend to use gas which is considered as clean energy except the families who earned the monthly income less than 100000 Rwandan francs (Kiyawa and Yakubu, 2017).

**TABLE 5**  
**MONTHLY COST FOR COOKING ENERGY**

Type of Energy		Firewood		Charcoal		Gas	
		Count	Percent	Count	Percent	Count	Percent
Cost of cooking Energy per month	Between 5,001-10,000	2	100	6	7.2	0	0
	Between 10,001-15,000	0	0	8	9.7	1	4.6
	Between 15,001-20,000	0	0	42	50.6	19	86.4
	Between 20,000-30,000	0	0	27	32.5	2	9
Total		2	100	83	100	22	100

## IV. CONCLUSIONS AND RECOMMENDATIONS

### 4.1 Conclusion

The research findings showed that the choice of type of energy used for cooking in informal settlements of Kigali City is influenced by family size and monthly income of the household. The research findings confirmed that clean energy use in informal settlements of Kigali city is used to a small extent where dominant type energy used for cooking is charcoal; this is due to its accessibility and affordability. Even if charcoal is most used energy type for cooking in informal settlements of

Kigali City, charcoal is very expensive than LPG on monthly basis but 77.6% people prefer to use charcoal as they can buy a small basket of charcoal to cook one meal which is different from buying a cylinder of LPG at one moment.

#### **4.2 Recommendations**

To address challenges associated with the use of clean energy use in informal settlements of Kigali City, some recommendations were proposed as follow:

- To reduce or remove taxes for LPG traders;
- To mobilize National Environmental fund to support poor family in regards with clean cooking energy especially for the first installation;
- The Government can work closely with financial institutions to provide loans with low interest for clean energy equipment
- Households living in informal settlements are requested to save money for longtime that help them to get clean energy initial cost

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