Hosted by

Household Energy Conservation Practices Used in Chalimbana Ward, Chongwe District

Alfred Chewetu and Progress H. Nyanga

Department of Geography and Environmental Studies

The University of Zambia, Great East Road Campus, Lusaka, Zambia

Corresponding author: Alfred Chewetu, email:chewetualfred@yahoo.com

DOI 10.53974/unza.jabs.7.1.1066

ABSTRACT

Energy conservation is a subject that has continued to attract global attention as it is essential in ensuring that the growing energy demand does not pose a threat to the environment. In view of this, the current study aimed at finding out the household energy conservation practices used in Chalimbana ward of Chongwe District, Zambia. The study adopted a convergent mixed-method research design. Qualitative data from 10 purposively sampled key informants was collected through in-depth interviews using semi-structured interview guides. Additionally, quantitative data from 175 households selected through cluster sampling technique was collected using a questionnaire. The qualitative data was analysed through content analysis, whereas quantitative data was analysed through descriptive statistics and multiple linear regression.

The study found that most households in Chalimbana ward depend on traditional biomass energy (Charcoal and firewood). Through multiple linear regression, the study found that expenditure on household energy consumption in the study area is influenced by social and economic factors such as family size, house size and education. To conserve energy, the households in this area use a variety of conservation methods, of which the most used involves switching or putting off unused household energy appliances or sources. The energy used among these households causes air pollution, habitat loss, land use change, and exposure to hazardous waste, among other environmental atrocities. While the study findings show that households in Chalimbana ward do practice energy conservation, this is not done at a substantive level that can yield sustainable environmental, economic and social benefits of household energy conservation.

Keywords: Household, Energy, Conservation and Chongwe

1. INTRODUCTION

Globally, energy conservation is a subject that has continued to attract global debate and attention, especially after the 1990s when climate change topics were at a peak (1). The debate has been anchored on various environmental

and climate change concerns resulting from energy generation and utilisation. In 2017, for instance, global energy-related Carbon Dioxide (CO_2) emissions rose by 1.6% after three years, and early data suggests continued growth in the proceeding years, far above a trajectory for global climate change goals (2).

The discussion about energy conservation has included global, diverse energy forms, which exist and are used at various scales: global, regional, national, community and household levels. Among these scales, the household level is considered the terminal link for energy consumption and sustained environmental protection (3). This is because household energy consumption does not only directly affect the scale and growth of energy consumption and carbon emissions but also drives the emission of the construction, transportation and service industries (4). Households encompassed in the residential sector are responsible for 17% of global CO_2 emissions and constitute the third-largest major energy consumer worldwide (5).

Household energy conservation also remains key in meeting socioeconomic needs and alleviating the energy deficits experienced in the African continent due to the rising population and under-developed energy systems (6). In Zambia, household energy conservation is also vital in meeting the increasing energy demand largely consumed by the mining sector (51.1%), followed by household consumption (33.2%) (7). However, the need to conserve energy resources poses a variance imperative to the need for development. This is despite the country being challenged with energy deficits and a lack of electricity access, of which in 2015, only about 22% of the urban population was connected to the national electricity grip, whereas in rural areas, the rate dropped to 3% (8). Additionally, the growing energy sector has posed concerns on climate change and the environment in Zambia, accounting for 19% of national Green House Gases (GHGs) emissions from anthropogenic activities (9).

The lack of a national energy efficiency policy in Zambia acts as a significant barrier in promoting environmental protection through sustainable use of resources for energy generation (10). Furthermore, a lack of household energy conservation practices can also significantly constrain national efforts for climate change and environmental protection. This is because households account for the second largest share of energy consumption in the country, which stood at 33.2% in 2019 (7). Therefore, if not managed well through household energy conservation, the increased energy demand in Zambia poses a threat to the environment. In this regard, the study aimed at finding out the household energy conservation practices used in Chalimbana ward of Chongwe District, Zambia.

2. MATERIALS AND METHODS

2.1 Study Area

The study was undertaken in the Chalimbana ward, which is in Chongwe District of Lusaka Province in Zambia. It lies about 35 Kilometres off Great East Road from Lusaka city. The ward, as shown in Figure 1, borders Kanakantapa, Chongwe, Nkatatindi, Lukoshi, Manyika, Machilele and

Nyangwena wards of Chongwe District (see Figure 1).

Chalimbana ward has a savanna-type of climate and falls in agro-ecological region IIa of Zambia (11). Although tempered with by deforestation, this area has three main types of vegetation. These include dry miombo (*Brachystegia)*, mopane (*Colophospermum mopane*), and munga (*Acacia*) woodlands (12).

Agriculture is the main economic activity by residents of Chalimbana ward. Commonly cultivated crops in the area include maize, cassava and sweet potatoes (11). Chalimbana ward was selected as the study area because it provides a general but substantive representation of Zambian communities. It has households connected to the national ZESCO electricity grid as well as those using traditional household energy sources such as firewood and charcoal.

2.2 Study Design

The study adopted a convergent mixed-method research design. In this research design, a researcher collects both quantitative and qualitative data, analyses them separately, and then compares the results to see if the findings confirm or disconfirm each. Its key assumption is that both qualitative and quantitative data provide different types of information, and together, they yield results that should be the same (13). Therefore, the two data sets in this study were collected and analysed concurrently but separately using typical quantitative and qualitative analytical procedures.

2.3 Sampling Strategy

Purposive non-probability sampling was used to sample the 10 key informants of the study. This sampling technique entails that the researcher used his or her own judgement when selecting study participants (14). The key informants were from an energy institution operating in Chalimbana ward, the local headmen, the area ward councillor and employees of Chongwe District Municipal Council. Additionally, the 175 Chalimbana ward households that participated in the study were sampled using the two-stage cluster sampling technique. This is a probability sampling method in which clusters of participants that represent the population are identified and included in a sample (15).

2.4 Data Collection and Tools

Qualitative data from 10 purposively sampled key informants was collected through in-depth interviews using semi-structured interview guides. In addition, the quantitative data from the 175 households was collected through a research survey using a questionnaire.

2.5 Data Analysis

The qualitative data was analysed through content analysis. The analysis was done from lower-level abstraction (close to the text and manifest content) to the higher levels of abstraction (reflecting the interpreted, latent meaning of the text) (16). Qualitative data was analysed through descriptive statistics and multiple linear regression.

3. RESULTS AND DISCUSSIONS

3.1 Household Energy Technologies Used

More than 90% of the households in Chalimbana ward are not connected to the national ZESCO electricity grid. Most of the households in the ward depend on traditional biomass (Charcoal and firewood), which accounts for more than 50% of their energy needs, as shown in Figure 2. These study findings are coherent with the available literature, which notes that Zambia is undersupplied with renewable energy, with most households still reliant on traditional biomass from charcoal and firewood (17). This traditional biomass energy accounts for more than 70% of local energy requirements (7), (18).

Renewable energy technological services are unaffordable to most of the poor in rural and peri-urban areas of developing countries (17). Chalimbana ward, hence being a rural area, has households inclined to high use of charcoal and firewood, with a few accessing renewable energy provided through ZESCO electricity or home-generated solar energy. The high dependence on biomass energy, according to the study key informants, is mainly because it is affordable and easily accessed by households in Chalimbana ward.

In terms of purpose, Charcoal, firewood, biomass residues and ZESCO electricity are the only forms of energy used for cooking in Chalimbana ward. Yet again, biomass in the form of firewood and charcoal accounts for the largest share (80%) of energy used for cooking in this area. These findings are like findings obtained in other parts of Zambia which, as shown by those who note that the three main cooking fuels in Zambia are firewood, charcoal and electricity (19). The key energy sources used for lighting in Zambia include electricity, candles, diesel, open fires, solar panels, and torches (1). Similarly, regarding household lighting, ZESCO electricity, cell batteries and petroleum products inform of kerosene, diesel and candles are used in Chalimbana ward. Among these, solar energy is mostly used for household lighting.

The study findings also reveal that entertainment, laundry, cleaning temperature control and communication purposes were also used to determine the energy technologies used among Chalimbana households. In this regard, it was found that the majority of the households with appliances that save for the previously listed purposes are connected to ZESCO, followed by those with home-generated solar energy. This indicator entails that the majority of the households in Chalimbana do not have entertainment, laundry, cleaning and temperature control energy technologies.

3.2 Energy Consumption Patterns Among Households

3.2.1 Household Expenditure on Energy Consumption in Chalimbana Ward

The study findings, as shown in Table 1, indicate that households with ZESCO electricity averagely spend more on energy consumption. This is because ZESCO electricity cannot be accessed for free compared to other energy sources, such as firewood and charcoal, which is mostly used in the area. The high reliance on inefficient biomass

energy in the low-income earning households of Zambia is because it comes free or is inexpensive compared to other household energy forms (20).

3.2.2 Social Economic Factors Influencing Household Expenditure on Energy

A multiple linear regression model was used to understand the influence of socioeconomic factors (household head monthly income, household head number of years in school, number of household members, number of house rooms, gender of the household head and household head marital status) on the average monthly amount spent in Zambian kwacha on all energy sources (ZESCO, solar, charcoal, firewood, biomass residues, petroleum products and cell batteries) used among Chalimbana ward households that took part in the study.

The findings of this analysis are presented in Table 2. The socioeconomic factors with positive coefficients in Table 2 all indicate that they are significant factors in influencing household average monthly expenditure on energy consumption, with the number of rooms being the most significant factor. These findings confirm the argument that there is a causal link between energy consumption and economic growth, as an increment in the latter will influence energy demand (21). The findings also confirm scholarly information, which shows that variables such as the household head's gender and occupational and educational attainment, as well as household location and size, are key determinants of not only the propensity to conserve energy but also levels of actual energy savings (22).

3.2.3 Chalimbana Ward Household Energy Conservation Methods

The study findings in Table 3 conform to the Social Practice Theory by showing the routinised type of methods used for energy conservation among households of Chalimbana ward (23). According to the key informants, the major reason to conserve energy in any form among households in Chalimbana ward is to reduce household expenditure on energy. This, as such, questions if the practice of energy conservation would be upheld if the economic situation of Chalimbana ward households is positively enhanced. It also questions if energy conservation in the study area is being used as a tool for promoting a steady energy supply at the household level while meeting global concerns over energy-induced environmental issues (6).

3.3 Environmental Implications of Consumed Household Energy

Energy is the essential material basis for economic and social development. However, if not sustainably utilised, it leads to a serious threat of climate change, environmental pollution and human health (24). Accordingly, the environmental effects of household energy sources or forms used among Chalimbana ward households vary and are complementary, at times (see Table 4). The air pollution resulting from burning biomass in the form of charcoal and firewood, as observed in Chalimbana ward, causes risk to households' health by creating levels of air pollution greater than those allowed by international ambient air quality standards on consumption patterns, among other factors (25).

Cutting down trees to meet the household energy needs, provided through charcoal and firewood causes losses of niches for various ecological species (26). Furthermore, deforestation driven by the demand for charcoal and firewood is also responsible for weather alterations, soil erosion and land use change, according to the study findings. Deforestation is interlinked with these effects as the practice of unsustainable cutting of trees has a contagious effect on the environment (27). It is, therefore, important that the households of Chalimbana ward switch to the use of renewable energy, such as solar energy. According to a few of the study participants, solar energy is only believed to be responsible for exposure to hazardous waste because of the electronic waste generated by solar energy devices or components. However, through effective electronic waste management practices such as recycling, this challenge would be curbed (28).

4. CONCLUSION

Energy sources and forms used among these households include charcoal, firewood, ZESCO electricity, petroleum products, solar, cell batteries and biomass agriculture residue, with charcoal being the most used. Accordingly, expenditure on household energy consumption in the study area is influenced by socioeconomic factors of which income, family size, house size and education also play a role. To conserve energy, the households in this area use a variety of conservation methods, of which the most used involves switching off unused household energy appliances or sources.

The study also found that household energy, if not sustainably utilised as in Chalimbana, causes air pollution, habitat loss, land use change, and exposure to hazardous waste, among other environmental atrocities. It is, therefore, concluded that households in Chalimbana, ward do practice energy conservation. However, this is not done at a substantive level that can yield sustainable environmental, economic and social benefits of household energy conservation.

ACKNOWLEDGEMENTS

I would like to acknowledge and appreciate my study participants from Chalimbana ward and Chongwe District as a whole.

Malama A, Makashini L, Abanda H, Ng'ombe A, Mudenda P. A Comparative Analysis of Energy Usage and Energy Efficiency Behavior in Low- and High-Income Households: The Case of Kitwe, Zambia. Resources. 2015; 4: p. 871-902.

IEA. World Energy Outlook Paris: International Energy Agency; 2018.

Yue T, Longa R, Chen H, Imran M. Research of Effect of Energy-conservation Results: Evidence. 104 (2016). Energy Procedia. 2016; 104: p. 293-298.

Yue T, Long RY, Chen H, Zhao X. The Optimal CO2 Emissions Reduction Path in Jiangsu province: An Expanded IPAT Approach. Appl Energy. 2013; 112: p. 1510-1517.

Nejat P, Jomehzadeh F, Taheri MM, Gohari M. Global Review of Energy Consumption, CO2 Emissions and Policy in the Residential Sector (with an overview of the top ten CO2 Emitting Countries). Renewable and Sustainable Energy Review. 2015; 43: p. 843-862.

Ouedraogo NS. Africa Energy Future: Alternative Scenarios and their Implications for Sustainable Development Strategies. Energy Policy. 2017; 106: p. 457- 471.

Ministry of Energy. National Energy Policy Lusaka: Ministry of Energy; 2019.

World Bank and International Energy Agency. "Progress Toward Sustainable Energy: Global Tracking Framework 2015". Washington DC.

USAID. Green House Gas Emmission in Zambia. [Online].; 2015. Accesed on 24th August 2023 from: https://pdf.usaid.gov/pdf_docs/pa00msrj.pdf.

Mwamba R, Guo R, Kuch S. Zambia's Energy Consumption and Related Carbon Emissions. International (IJSRP). Journal of Scientific and Research Publications. 2020; 10: p. 9938.

Mubanga HK. Smallholder Farmer's Livelihood Diversification As A Response to Climate Changed Climatic Patterns in Chongwe District Zambia. Journal of Agriculture Policy (JAP). 2020; 3(1): p. 1-17.

Mulupi ID, Chileshe B, Moonga MS, Monde PN. Women and Natural Resource Conservation: A Study of Chongwe district, Zambia. International Journal of Humanities Social Sciences and Education (IJHSSE). 2020; 7(3): p. 22-30.

Cresswell JW. Qualitative, Quatitative and Mixed Method Approach California: Sage Publication; 2014.

Black K. "Business Statistics: Contemporary Decision Making". 6th ed. Chichester: John Wiley and Sons; 2010.

Jackson SL. "Research Methods and Statistics: A Critical Approach". 4th ed. Boston: Cengage Learning; 2011.

Christen E, Petra B. A Hands-on Guide to Doing Content Analysis. African Journal of Emergency Medicine. 2017; 7(3): p. 93-99.

Mudenda PK, Makashini L, Malama A, Abanda H. Review of Renewable Energy Technologies in Zambian Households: Capacities and Barriers Affecting Successful Deployment. Buildings. 2018;: p. 1-14.

IEA. Zambia-Country Profile Paris: International Energy Agency.; 2020.

Luzi L, Lin Y, Koo BB, Rysankova D. Zambia – Beyond Connections: Energy Access Diagnostic Report Based on the Multi-Tier Framework. Environmental Science; 2019.

Baltruszewicz M, Steinberger JK, Owen A, Brand-Corea LA, Paavola J. Final Energy Footprints in Zambia: Investigating Links between Household Consumption, Collective Provision, and well-being, Volume. Energy Research and Social Science. 2021; 73: p. 101960.

Zaharia A, Diaconeasa MC, Brad L, Ladaru GR, Ioanas C. Factors Influencing Energy Consumption in the Context of Sustainable Development. Sustianability; 2019 11(4147): p. 1-28.

Mutua J, Kimuyu P. Household Energy Conservation in Kenya: Estimating the Drivers and Possible Savings Nariobi: Environment for Development; 2015.

Higginson SL, McKenna E, Thomson M. Can Practice Make Perfect (models)? Incorporating Social Practice theory into Quantitative Energy Demand models. En: Third Behave Energy Conference,Oxford: EST-UKERC; 2014 p. 3-4.

Zhao C, Niu S, Zhang X. Effects of Household Energy Consumption on Environment and its Influence Factors in Rural and Urban Area. Energy Procedia. 2012 p. 805-811.

World Health Organization (WHO). Household Air Pollution and Health. Geneva: WHO.

Dlamini C, Moombe KB, Syampungani S, Samboko PC. Loadshedding and Charcoal Use in Zambia: What Are the Implications on Forest Resources? Lusaka: Indaba Agricultural Policy Research Institute; 2016.

Kasaro D, Phiri E, Nyambe I. Deforestation Impact on Ecosystem Services in Kamfinsa sub-catchment of Kafue River Basin in Zambia. African Journal of Environmental Science and Technology. 2019; 4(11): p. 34-43.

Nidhi J, Jaykumar S. Sustainable Attainment of Solar E-waste Recycling Concerning to COVID-19 Crisis: A Review. Research Gate. 2021;: p. 211-223.

TABLES

Table 1: Estimated Monthly Expenditure on Energy Consumption in Chalimbana Ward Households

Energy Sources	No. Of Households	Min (ZMW)	Max (ZMW)	Sum (ZMW)	Mean (ZMW)	Std. Deviation
Firewood	127	0	80	270	2.1	12.0
Petroleum Production	43	10	100	1050	24.4	14.2
Cell Batteries	56	10	80	1275	22.8	13.5
ZESCO	46	50	650	9860	214.3	119.0
Charcoal	148	0	500	15653	105.8	81.1

Source: Field Data

Table 2: Regression Analysis Output Coefficients

Term	Coef.	SE Coef.	T-Value	P-Value	VIF
Constant	-8.44	5.43	-1.56	0.122	
Household Head Monthly Income	0.001543	0.000522	2.96	0.004	2.48
Household Head Years in Formal Education	0.947	0.377	2.51	0.013	1.74
Number of Household Members	0.033	0.633	0.05	0.958	1.47
Number of Rooms in the House	6.81	1.20	5.68	0.000	2.47
Household Head Gender					
Male	-6.57	3.07	-2.14	0.034	1.43
Household Head Marital Status					
Not Married	1.03	3.35	0.31	0.758	1.60

Source: Field Data

Table 3: Chalimbana Ward Household Energy Conservation Methods

Conservation Methods	Percent
Not using many household appliances or sources at once	3.0%
Switch or put off unused energy appliances or sources	70.1%
Substitute one energy source for another depending on the required purpose	26.9%
Total	100.0%

Source: Field Data

Table 4: Distribution Suggested Adverse Environmental Implications of Household Energy

Environmental Impacts	Energy Sources							Total
	Firewood	Charcoal	Petroleum Products	ZESCO	Biomass Residues	Cell Batteries	Solar	
Deforestation	50.8%	47.6%	0.0%	1.6%	0.0%	0.0%	0.0%	100%
Air Pollution	42.5%	16.9%	34.5%	0.0%	6.1%	0.0%	0.0%	100%
Soil Erosion	87.5%	12.5%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
Habitat Loss	25.0%	25.0%	0.0%	50.0%	0.0%	0.0%	0.0%	100%
Weather patterns Alteration	50.0%	46.2%	0.0%	3.8%	0.0%	0.0%	0.0%	100%
Exposure to Hazardous Materials	0.0%	0.0%	0.0%	0.0%	0.0%	96.5%	3.5%	100%
Land Use Change	11.1%	0.0%	0.0%	88.9%	0.0%	0.0%	0.0%	100%
Loss of Aquatic Life	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100%

Source: Field Data

FIGURES

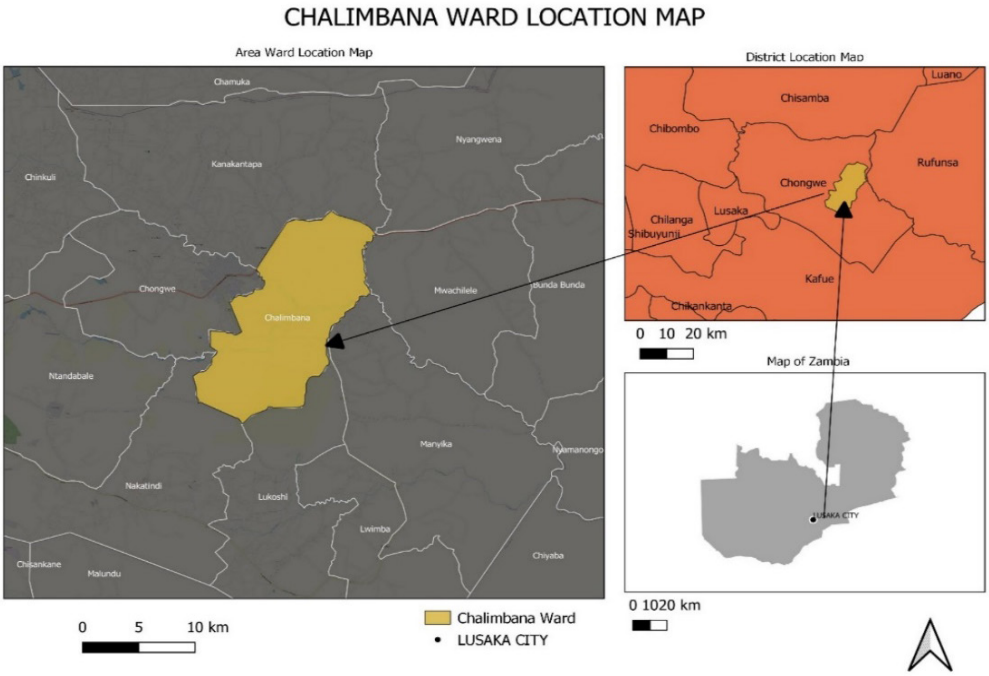

Figure 1: Chalimbana Ward Location Map

Source: Researcher

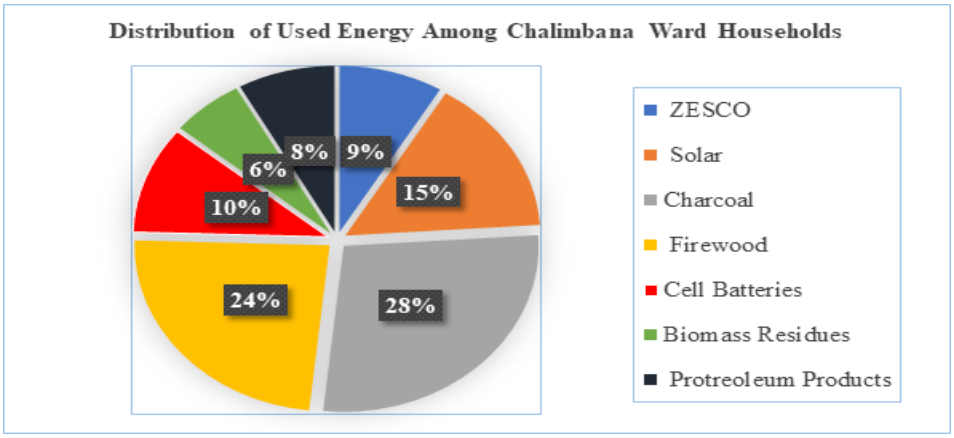

Figure 2: Percent Distribution of Most Used Energy among Chalimbana Ward Households

Source: Field data