African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

REMITTANCES AND HOUSEHOLD ADOPTION OF CLEAN COOKING ENERGY IN GHANA

Kyeremeh, C.[1] and Fiagborlo, D. J. [2]
[1]*Faculty of Business and Management Studies, Sunyani Technical University, Sunyani, Ghana.*
[2]*Department of Multidisciplinary Studies, Faculty of Applied Social Sciences, Ho Technical University, Ho, Ghana.*
[1]*ckyeremeh@stu.edu.gh*
[2]*jfiagborlo@htu.edu.gh*

ABSTRACT

Purpose: Access to clean and sustainable energy sources promotes long-term economic growth by improving environmental quality and human well-being. However, most homes in poor nations depend on polluting solid fuels, which has profound implications for environmental sustainability and human health. This study examines the impact of remittance inflows on household decisions related to clean cooking fuel. It evaluates the effects of remittance income on selecting clean energy for cooking in Ghana's rural and urban regions.

Design/Methodology/Approach: The study used probit regression and data from the seventh wave of the Ghana Living Standards Survey.

Findings: The results show that while remittance inflows significantly and positively influenced clean cooking energy choices, their effects are more significant on urban families' clean energy choices than rural households. Families in rural and urban areas positively and significantly connect their clean energy usage to non-remittance income and education. In contrast, household size, rural location, age, and poverty negatively influence using clean cooking energy. Finally, deprived urban residents may choose alternative energy sources over clean cooking fuel.

Research Limitation: This research focused on remittances and household clean cooking fuel in Ghana.

Practical Implication: The results suggest that economic factors, demographic characteristics, and socioeconomic status influence clean energy adoption.

Social Implication: The findings imply that devising the right policies to encourage remittance inflows and addressing causal poverty issues presents viable options for policymakers.

Originality/Value: By examining the impact of remittances on household decisions related to clean cooking fuel in the Global South, a topic largely neglected in existing literature, the study adds to the body of knowledge on energy consumption in developing countries. The study provides significant insights for policymakers and stakeholders promoting sustainable energy transitions.

Keywords: *Adoption. clean energy. cooking fuel. household. remittances.*

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

INTRODUCTION

Energy is critical for both economic growth and human development. Increased availability of clean and sustainable cooking fuels is vital to realising Goal 7 of the United Nations (UN) Sustainable Development. Clean cooking energy has several advantages, including environmental protection, health promotion, women's empowerment, and improved quality of life (Ntegwa & Olan'g, 2024). Clean fuels are directly associated with social well-being and environmental quality (Hosan et al., 2023; Goldemberg et al., 2018). Despite this, access and consumption of clean energy remain critical issues in developing countries. These countries increasingly need sustainable and affordable energy sources to promote sustainable development and reduce environmental pollution (Kovalskyi et al., 2024). Most households in developing nations lack access to clean and modern fuels, relying primarily on unclean solid fuels for cooking and heating. Over 3 billion individuals worldwide lack access to clean fuels, predominantly in sub-Saharan Africa and Asia (Frostad et al., 2022). In sub-Saharan Africa, 75 percent of the population depends on unclean fuels (e.g., kerosene, wood, animal dung, crop waste, and coal) for cooking, highlighting significant energy deprivation (Bensch et al., 2021; IEA, 2020). In most Ghanaian households, wood-based fuels serve as the primary source for cooking and heating. Figure 1 demonstrates that more than 70% of Ghanaian households rely on solid fuels like firewood and charcoal for cooking, despite the government and international agencies implementing several programmes and interventions to encourage the usage of clean energies in the country (Ghana Energy Commission [GEC], 2022).

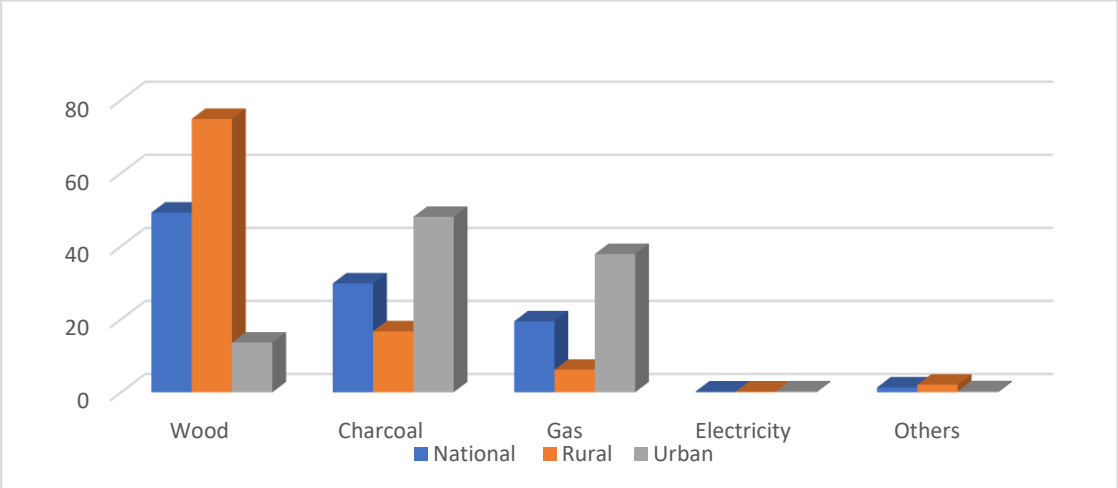

Figure 1. Main fuel used by households for cooking in Ghana
Source: Ghana Living Standard Survey (GLSS 7)

The continued use of dirty fuels is an environmental health concern. Consumption of wood-based fuel contributes to environmental degradation and climate change. Harvesting wood for

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

cooking fuel causes deforestation and carbon emissions (Lukashevych et al., 2024; Rahut et al., 2019). Moreover, the use of solid fuels presents severe health risks to households (Andrade-Rivas et al., 2024; Basu et al., 2024; Yang & Chen, 2024). There is significant evidence that household exposure to smoke from burning solid fuels causes health issues and early mortality, with women and children being the most vulnerable. Cooking with unclean and inefficient fuels directly contributes to poor health, a depressed quality of life, gender inequality, and climate change (Odame & Amoah, 2023). To address the environmental and health risks of solid fuel use, the UN set out Goal 7 of Sustainable Development. This goal calls for worldwide access to clean, affordable, sustainable, modern, and environmentally friendly energy by 2030. This commitment enjoins governments and policymakers to devise policies that promote clean energy transition. Understanding the factors affecting access to and use of clean fuels helps policymakers develop appropriate policies in the energy sector to improve household use of clean fuels and minimise environmental pollution. Previous studies have shown that factors like education, wealth, financial inclusion, poverty status, fuel accessibility, price, household size, and income inequality influence households' choice of cooking fuel (Abokyi et al., 2024; Ntegwa & Olan'g, 2024; Awan et al., 2023; Islam et al., 2023), but the relationship between income remittance and clean energy use remains little understood. However, receiving remittances helps improve household income and may encourage households to adopt clean energy.

Remittances are money or goods that travellers send back to family or friends in their home countries (IMF, 2009). These funds are a significant source of external finance for developing nations, outperforming conventional sources of foreign capital such as foreign direct investment (FDI) and official development aid (ODA). At the micro level, remittances are a significant financial resource for households, enhancing their livelihoods by offering an alternative income source. Remittances influence households directly, enhancing their consumption compared to other external financing sources. Therefore, increasing remittances can substantially enhance income, stabilise household consumption, and alleviate credit constraints (Amuedo-Dorantes, 2014). Remittances assist low-income households in addressing financial challenges by enhancing income, facilitating consumption, and alleviating capital constraints. Research indicates that remittance inflows enhance household income and significantly improve living standards in developing nations (Barkat et al., 2023; Chen et al., 2023). In this context, increasing remittances can alleviate household energy deprivation and enhance the adoption of clean energy. Thus, remittances may expedite the transition to clean energy and reduce household air pollution.

Remittance inflows to sub-Saharan African economies have increased significantly over the past decades. Data shows that household remittances in the region surged from $39 billion in 2016 to $53 billion in 2022, with the upward trend expected to continue (DMAG, 2018; World

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

Bank, 2022). In 2021, Ghana received US$4.5 billion in remittances, which represents 5.9 percent of the country's gross domestic product (GDP). The government's policies to ease the burden of money transfers to the country may have contributed to this surge in remittance inflows. The growing number of banks and the enhanced flexibility of transferring funds internationally via mobile money illustrate this trend. The following question requires a response: How does income remittance impact household energy consumption? Evidence indicates that remittance inflows are a significant financial resource for households, as these funds typically reach households directly rather than through public finance channels (Musah-Surugu et al., 2017). However, previous research has not thoroughly investigated the role of migrants' remittances in facilitating the clean energy transition. This research addresses the gap by analysing the impact of remittances on households' adoption of clean cooking fuels. Assessing the impact of remittances on the selection of clean and efficient fuel enhances a deeper understanding of Ghanaian households' decision-making processes and the effects of remittance income on sustainable energy consumption. By financing investments in energy systems that enhance the use of clean energy, remittance income can promote sustainable development in Ghana.

This study adds to the existing body of research on energy consumption in developing nations in the following domains: This study examines the impact of remittance inflows on household decisions related to clean cooking fuel in the Global South. This topic has been largely neglected in existing literature. Secondly, the study employs a nationally representative micro dataset, enabling micro-level analysis, unlike previous studies that depended on macro datasets (Barkat et al., 2023; Chen et al., 2023; Djeunankan et al., 2023). Thirdly, the study conducts subnational analysis by examining how remittance income impacts the rural-urban disparities in clean energy adoption compared to past studies that performed national analysis.

Section 2 of the article reviews the literature. Section 3 outlines the methodology, detailing the empirical framework, estimation technique, and data utilised. Section 4 delineates the results and analyses the findings. The concluding section outlines the findings and discusses their policy implications and limitations.

THEORIES UNDERPINNING THE STUDY

The corpus of literature on clean cooking fuel consumption in underdeveloped countries is minimal but rising. Previous research has found a variety of variables that impact the availability and usage of clean cooking fuels (Ali & Khan, 2022; Abokyi et al., 2024; Haq et al., 2024; Ntegwa & Olan'g, 2024). Income, household size, location, education, age, gender, employment, price, and environmental and technological effects are among the variables considered. Some studies (Yadav et al., 2021; Endalew et al., 2022; Guta et al., 2022; Ali et al., 2024; Oyeniran & Isola, 2023) have found income as a strong predictor of access to and

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

use of clean energy. Income, in theory, promotes clean energy consumption by making it more affordable and expanding customer options and preferences. Increased income enables people to acquire and use sustainable cooking energy sources, including electricity and liquefied petroleum gas (LPG) (Endalew et al., 2022).

The energy ladder hypothesis emphasises the significance of income in the transition to clean fuels (Muller & Yan, 2018). This theory posits that household fuel transition occurs in a linear progression, beginning with traditional fuels like wood, coal, animal dung, and crop residue, followed by transitional fuels such as charcoal and kerosene, and culminating in clean fuels like electricity and gas as income increases (Mainimo et al., 2022). Therefore, the theory postulates a positive correlation between income levels and sustainable energy sources, suggesting that increased income promotes the adoption of clean cooking fuels. Critics question the theory's premise that households transition entirely from one fuel category to another as income increases. In developing countries, households do not entirely abandon solid fuels with rising incomes; instead, they often employ a mix of solid and clean fuels (Choudhuri & Desai, 2021). Muller and Yan (2018) proposed the energy stacking theory to explain this practice.

Fuel stacking theory suggests that households employ a varied fuel use strategy, choosing from both efficient and inefficient fuel sources. Various studies (Gould et al., 2018; Ochieng et al., 2020; Price et al., 2021; Perros et al., 2023) on domestic energy consumption in developing countries have confirmed the fuel stacking theory. For instance, while Price et al. (2021) identified that households in Cambodia, Myanmar, and Zambia employ a combination of clean and unclean fuels for cooking purposes, Ochieng et al. (2020) noted that Kenyan households employ a mix of biomass fuels and LPG to meet their cooking needs. Some papers (Rahut et al., 2019; Yadav et al., 2021; Rubinstein et al., 2022; Ali et al., 2024; Parvizi et al., 2024; Perros et al., 2023) argue that fuel stacking arises from a variety of factors, such as income, fuel accessibility, pricing, cultural practices, cooking technologies, and knowledge of energy. The energy stacking theory indicates a partial fuel transition, while the energy ladder theory proposes a complete fuel transition; however, both theories underscore the significance of income level in selecting sustainable cooking fuel. While research (Endalew et al., 2022; Gould et al., 2020) indicates a positive correlation between income and clean energy consumption, recent investigations by Ali et al. (2024), Haq et al. (2024), and Ntegwa & Olan'g (2024) further corroborate this finding. Using sustainable cooking energies in Ecuador positively correlated with wealth (Gould et al., 2020). Ethiopian scholars' research reveals an inverse relationship between household income and the use of solid fuel (Endalew et al., 2022). Moreover, the high initial equipment and fuel refill costs hinder LPG adoption and sustained use (Gould & Urpelainen, 2018; Stanistreet et al., 2019). This suggests that expanding household income sources may enhance sustainable cooking energy use.

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

Musah-Surugu et al. (2017) assert that remittances sent directly to recipients are a crucial financial resource for families. Barkat et al. (2023) and Chen et al. (2023) further contend that remittances boost household income, improving quality of life. Recent studies (Mishra et al., 2022; Ortega et al., 2024) also show that remittances influence household purchasing habits. While remittance income has the potential to affect the adoption and usage of clean cooking fuels, there has been little study into the effect of remittances on cooking fuel use, with a significant emphasis on places other than Africa.

Wijayarathne et al. (2022) investigated the effect of remittances on the utilisation of sustainable cooking energy in Sri Lanka, employing propensity score matching analysis on household-level data. The findings from this study revealed that remittances positively influence clean fuel use. Similarly, Hassan (2020) investigated the impact of remittance on Bangladesh's use of LPG. The study sampled 610 households from three districts in southern Bangladesh. A probit regression model was used to determine that remittance positively affects LPG usage, concluding that such transfers encourage the adoption of clean energy sources. Osei-Gyebi (2023) used logistic regression to examine the impact of remittances on cooking fuel selection in Ghanaian households. The findings indicate that remittance income positively impacts the use of sustainable cooking fuels. While the study examined household preferences for polluting and non-pulling fuels nationally, it does not address how remittances affect cooking fuel usage in rural and urban areas. Therefore, the present research assesses the effects of remittances on cooking fuel usage and examines the effects of remittances on clean cooking fuel choice across rural and urban Ghanaian families.

Besides remittance income, socioeconomic and demographic characteristics influence cooking fuel use. Evidence (Ali & Khan, 2022; Rahut et al., 2022; Twumasi et al., 2022; Yunusa et al., 2024) indicates that education enhances comprehension of the health and environmental consequences of energy consumption, thus encouraging the adoption of clean fuel. While higher fuel demand and an excess of labour for wood gathering correlate household size with the use of firewood and charcoal (Guta, 2018), families led by women are more likely to utilise neat cooking energy compared to those led by men (Haq et al., 2024). In low-income countries, women are responsible for cooking and other household tasks that necessitate fuel. Additionally, they are the most susceptible to the adverse effects of dirty fuel consumption (Rahut et al., 2022). Research in developing countries has also found a positive correlation between clean cooking energy usage and income levels (Huang, 2015; Bisu et al., 2016; Oyeniran & Isola, 2023). The location of a home influences the energy source used for cooking. For instance, studies (Endalew et al., 2022; Abokyi et al., 2024) have demonstrated an inverse correlation between a household's rural residency and the use of sustainable cooking fuel.

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

The literature review indicated that while previous papers have explored the relationship between remittances and cooking energy use, the effect of remittance inflow on the adoption of clean cooking energies in Ghana and other regions remains underexplored. This study closes this gap by examining the impact of migrants' income on clean energy usage at national and subnational levels. The study aims to uncover relevant insights for shaping policies to inspire decisions about converting clean energy in families.

METHODOLOGY

Research Design

Using quantitative design, the study employed household data from the seventh round of the Ghana Living Standards Survey (GLSS 7), conducted by the Ghana Statistical Service (GSS) in 2016 and 2017. The GSS conducts the GLSS, a nationally representative evaluation that examines Ghana's households' living circumstances and well-being. The survey gathers essential household data across various domains: health, education, migration, housing, savings, consumption, agriculture, food, and income. The GLSS 7 represents the latest assessment of the nation's living standards. The GSS selected 14,009 households from various regions of Ghana using a two-stage stratified sampling method. Missing data on critical variables, such as income remittance and cooking fuels, reduced the study sample to 4,156 households. The analysis used data regarding the primary households' cooking fuel, remittance income, total household income excluding remittances, household size, geographical location, poverty status, and the features of household heads, including age, gender, and education level.

Model

This study aimed to assess the impact of remittance income on adopting clean cooking fuel among Ghana households. It accounted for additional socio-economic variables relevant to the analysis. The energy ladder hypothesis is the foundation for this research, suggesting that income significantly influences households' fuel choices. Households with limited income typically use solid fuels, which are unclean and environmentally detrimental, whereas higher-income households rely on modern and clean energy sources for cooking. Studies that analysed cooking fuel preference for households suggest that socio-demographic factors are essential determinants (Ali & Khan, 2022; Abokyi et al., 2024; Haq et al., 2024; Ntegwa & Olan'g, 2024;). Furthermore, in the literature, there is consensus that income is a significant determinant of household cooking fuel. This paper acknowledges that remittance income boosts household income and may facilitate the transition to clean cooking fuel. Hence, this study investigates the link between household adoption of clean energy and income remittance while controlling for extra socio-economic variables. The empirical model is stated as follows:

$$CE_i = \gamma + \delta lnRINC_i + X_i'\beta + \varepsilon_i \quad (1)$$

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

Where *CEi* represents a dichotomous dependent variable coded as 0 (unclean energy) and 1 (clean energy), *lnRINCi* represents the natural log of remittance income, which is a continuous variable, and X_i represents the control variables that are described in Table 1. γ represents the intercept, δ the coefficient of remittance income, and β signifies the vector of parameters for the control variables while ε is the stochastic error term. Expanding equation (1) to include all the variables used in the study, we have:

$$CE_i = \gamma + \delta lnRINC_i + \theta lnNRINC_i + \varphi HS_i + \tau HPS_i + \vartheta HL_i + \pi AHH_i + \sigma EHH_i + \omega GHH_i{+}{+}\varepsilon_i \quad (2)$$

Where CE_i is the dependent variable, $lnRINC_i$ is the main regressor in the natural log, $lnNRINC_i$ represents the log of the non-remittance income of the household, HS_i is household size, HPS_i is the poverty status of a household, and HL is the location of the household, while AHH_i, EHH_i and GHH_i represent the age, educational level, and gender of the household head, respectively. The regression parameters to be estimated are $\delta, \theta, \varphi, \tau, \pi, \sigma$ and ω, respectively.

Estimation Technique

The dependent variable in (2) is dichotomous; therefore, the ordinary least squares (OLS) method for estimation results in biased estimates and erroneous standard errors. The research used the probit regression model for empirical analysis to mitigate this estimation mistake. The probit model's estimate produces expected values within the acceptable probability range of 0 to 1. The probit regression model is represented as follows:

$$\Pr(Y = CE_i|R_i, X_i)) = \theta + \omega lnRINC_i + X_i'\beta + \varepsilon_i \quad (3)$$

In this context, ω and β denote the regression parameters, ln$RINC_i$ serves as the primary independent variable, and X_i encompasses the control variables, which include age, education, household size, non-remittance income, location, and poverty status. The CE_i represents the percentage of households that use cooking fuel.

Definition and measurement of variables

The study's dependent variable is whether or not a household uses clean cooking fuel. Clean cooking fuel sources include electricity and LPG (Puzzolo & Pope, 2017; Rahut et al., 2022). We created a binary variable based on the primary family cooking fuel. Remittance income is the study's independent variable of interest. Remittance income is defined as money that families receive from both domestic and foreign sources. It is a continuous variable measured as annul household remittance income in Ghana cedis. The paper accounts for non-remittance income, education, age, family size, gender, and location. Households obtain non-remittance income from various sources, including work, household agriculture, non-farm self-

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

employment, rent, pension incomes, and interest on savings and investments. Non-remittance income is the difference between total household income and remittance income. Family size is measured continuously as the total number of family fellows, while age is also a continuous variable measured in completed years. Education level assesses the household head's degree of education, categorised into three dummy variables: primary education, secondary education, and tertiary education, with research suggesting a positive impact on clean cooking fuel selection (Ali & Khan, 2022). Additional variables include gender (1 for female household head, 0 for male) and location (1 for rural, 0 for urban). The analysis also includes the prediction that poverty status (1 for poor/very poor, 0 for not poor) will negatively impact the use of clean cooking fuel, in line with Osei-Gyebi (2023). These variables provide a comprehensive understanding of the factors influencing household choices regarding clean cooking fuel.

RESULTS AND DISCUSSION

Demographic Information

The descriptive statistics for the variables utilised in the analysis are presented in Table 1. The results show that households' average remittance income was GHS 1302. The average gross household non-remittance income was GHS 21,973. Approximately 20% of households utilised clean fuel sources, including gas and electricity. Table 1 indicates that the average age of household heads is 46.7 years. About 32.5% of households were headed by women, and this lower proportion of female household heads is consistent with most African societies, where household heads tend to be mostly males. However, since females are typically responsible for cooking in the household, their decisions matter regarding cooking energy. Table 1 further shows that almost 53 percent of the household heads had primary education compared to 11.9% who had tertiary education. Besides, a significant proportion of the households (57.1%) lived in rural areas, with 26.6% being poor.

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

Table 1: Descriptive statistics of variables used in the model

Variable	Definition and measurement	Mean	SD
Clean fuel	Clean cooking fuel use (0= no, 1= yes)	0.196	0.397
Remittance	Annual remittance income of household (in Ghana cedis)	1302.692	3578.914
Non-remittance	Annual household income less remittance (in Ghana cedis)	21973.034	140294.54
Age	Age is a continuous variable measured in completed years	46.7	15.725
Household size	Household size is the total number of family members	4.3735	2.8488
Primary	Primary education of household head (0= no, 1= yes)	0.527	0.499
Secondary	Secondary education of household head (0= no, 1= yes)	0.277	0.267
Tertiary	Tertiary education of household head (0= no, 1= yes)	0.119	0.323
Female	Gender of household head (1 for female, 0 for male)	0.325	0.468
Rural	Location of household (0= urban, 1=rural)	0.571	0.495
Poor	Poverty status of household (0= non poor, 1= poor)	0.266	0.442

Source: Authors' computation from the GLSS7. Note: SD is the standard deviation

REMITTANCES AND CLEAN COOKING FUEL CHOICE

The research employed the probit model to evaluate the impact of remittances on using clean cooking energy while considering various socio-economic factors. We implemented the variance inflation factor (VIF) test to verify that the explanatory variables in the model are free from multicollinearity issues. Pallant (2020) states that multicollinearity occurs when VIF values exceed ten or the tolerance limit falls below 0.2. Table 2 indicates that the mean VIF values for the variables in the model are below 10, suggesting that multicollinearity was not a concern in this study. The Wald chi-square test results indicate that the model employed in this study demonstrates a superior fit compared to a model devoid of predictors. Table 2 displays the findings from the empirical analyses. The estimated coefficients of a Probit regression model lack direct interpretability. Consequently, we examine the entire, rural, and urban marginal effects in Table 2.

Table 2 indicates a significant positive correlation between remittance income and the use of clean energy across all models, suggesting that higher remittance income enhances the probability of opting for clean energy sources, such as gas and electricity, for cooking purposes. For each 10% increase in remittance income, the probabilities of selecting clean energy increase by 2%, 1%, and 4% for the entire, rural, and urban models, respectively, while controlling for non-remittance income, age, household size, gender, education, and poverty status. In terms of magnitude, the size of the marginal effects shows that remittance income substantially affects urban households more than rural ones. The plausible reason is that remittance income boosts revenue and increases households' ability to buy and use gas and electricity, which are relatively more expensive than unclean fuels. The results are consistent with findings from previous studies by Hassan (2020), Wijayarathne et al. (2022), and Aminu

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

et al. (2024), which demonstrate that households receiving remittances are more likely to choose clean cooking fuel over alternative, polluting fuels.

Table 2: Effect of remittance on clean cooking fuel use (marginal effect)

Variable	National		Rural		Urban	
	ME	Z	ME	Z	ME	Z
Remittance	0.022***	6.04	0.011***	3.30	0.037***	5.06
Non-remittance	0.030***	10.17	0.018***	6.61	0.047***	7.85
Age	-0.002***	-5.91	-0.0012***	-4.23	-0.0025***	-4.14
Female	-0.004	-0.39	0.005	0.50	-0.018	-0.89
Household size	-0.020***	-8.17	-0.015***	-6.51	-0.027***	-5.48
Primary	0.063***	5.93	0.014	1.45	0.142***	5.73
Secondary	0.195***	7.95	0.097***	3.39	0.340***	7.92
Tertiary	0.324***	14.21	0.206***	6.84	0.498***	13.55
Rural	-0.112***	-11.48	-	-	-	-
Poor	-0.139***	-4.94	-0.0795***	-4.00	-0.193**	-2.56
N	4,156		2,419		1737	
Wald chi^2 (10)	851.33		299.95		392.07	
Prob > chi^2	0.0000		0.0000		0.0000	
Pseudo R^2	0.3571		0.3533		0.2335	
Log pseudo likelihood	-1236.81		-396.21		-834.70	
Mean VIF	1.35		1.28		1.42	

*Source: Author's computation from GLSS7. *** p<0.01, ** p<0.05, indicate significant at 1% and 5% respectively. Note: ME is the marginal effect.*

Table 2 also illustrates the impact of various control variables. The findings indicate that household heads' non-remittance income and education level significantly positively affect household clean energy decisions. However, regardless of the households' rural or urban classification, the age of household heads, household size, and poverty status significantly negatively affect the selection of clean cooking energy. The findings demonstrate that a 10% rise in non-remittance income is associated with increases of 3%, 2%, and 5% in the likelihood of choosing clean energy in the entire rural and urban models, respectively. Furthermore, the size of the marginal impacts suggests that non-remittance income has a more substantial positive impact on urban families than on rural households. The results align with findings from other studies (Guta et al., 2022; Qiu et al., 2023), which revealed that higher-income households are more likely to utilise LPG and electricity.

A higher level of education increases the probability of selecting clean cooking energy for all households by 32%. The impact on clean cooking energy usage is 21% for rural households, and for urban households, it is 50%. The marginal impacts of education levels are more pronounced in urban households compared to rural and overall households. This may be

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

attributed to the greater availability of clean fuel options in urban areas relative to rural areas. Rural households face challenges in accessing clean fuels, including LPG and electricity. Clean fuel alternatives like wood and charcoal are more readily available in rural areas. The findings indicate that education positively influences the use of clean cooking energy at both national and sub-national levels. Studies by Twumasi et al. (2022), Rahut et al. (2022), and Qiu et al. (2023) corroborate the findings, suggesting that education heightens family awareness about the health risks linked to dirty cooking fuels, thereby fostering a feeling for clean fuel. Moreover, individuals with higher education levels face a more significant opportunity cost for wood collection than those who are illiterate, leading them to opt for cleaner cooking fuels. Gupta and Pelli's (2021) research, which found a positive correlation between education and LPG usage, also aligns with the findings.

Table 2 shows that a one-year increase in household heads' age reduces the likelihood of selecting clean cooking energy. The findings indicate that older households may favour conventional energy sources over clean alternatives. This finding corroborates the inverse relationship between age and clean energy utilisation as reported by Yunusa et al. (2024). Conversely, our findings challenge the conclusions of Endalew et al. (2022), who posited that older individuals generally favour clean cooking fuels owing to their financial means and the health advantages associated with clean and sustainable fuels compared to solid fuels, which negatively impact human health.

The results show that an increase of one person in household size reduces the probability of selecting clean energy by 2% in the complete model, 2% in the rural model, and 3% in the urban model, respectively. The findings indicate that larger households may prioritise energy needs over clean options. The magnitude of the marginal impacts indicates that household size substantially reduces the selection of clean energy for urban households in contrast to rural families. This result aligns with the findings of Oyeniran and Isola (2023), Ali and Khan (2022), and Mainimo et al. (2022), which indicate that families with a more significant number of members are less likely to use clean fuels for cooking. This shows that helping larger families may be a policy approach to encourage the shift from unclean solid fuels to clean fuels.

The findings demonstrate that poverty decreases the likelihood of selecting clean energy by 14%, 8%, and 19% for entire, rural, and urban households, respectively. The findings demonstrate that poverty status significantly decreases the probability of choosing clean energy, with a more pronounced marginal decline observed in urban households relative to rural households. This finding corroborates the research of Haq et al. (2024), which indicated that poor households exhibited a lower likelihood of adopting clean cooking fuels. Therefore, reducing poverty levels may promote adopting clean energy within households.

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

CONCLUSION

This research examined the impact of remittance income on clean fuel adoption while controlling for other socioeconomic factors in Ghanaian households. The research results indicate that remittance income more significantly influences urban families' clean energy choices than rural households. Similarly, families in both rural and urban areas positively and significantly connect their clean energy usage to non-remittance income and education. In contrast, household size, rural location, age, and poverty negatively influence the usage of clean cooking energy. Even though the marginal effects of household size show that larger urban households may use less clean energy, deprived urban people may choose other energy sources over clean cooking fuel. The findings suggest that economic factors, demographic characteristics, and socioeconomic status influence clean energy adoption.

Therefore, this paper recommends that policymakers explore innovative financing mechanisms that leverage remittance flows to support clean energy investment. Developing nations should utilise modern international money transfer services to enhance remittance levels and establish appealing and secure savings plans to encourage investment from overseas workers. To enhance the adoption of clean energy, developing programs targeting low-income households, younger demographics, and smaller households is essential. Policymakers should also initiate public campaigns that emphasise the advantages of clean energy, specifically aimed at older and larger households. Addressing underlying poverty concerns is a feasible alternative for energy policymakers. Finally, policymakers should consider providing incentives and subsidies to motivate disadvantaged people to use sustainable energy.

This paper may be subject to various limitations. An interaction between remittance income and poverty status could have mitigated any potential reverse causality between remittance income and clean energy choice. Even though we split the data to see how robust the results were, the fact that people may not remember everything because of time lapses could lead to wrong reporting of energy choice data in the GLSS, which would affect how reliable and valid the results are. Future studies should explore causal relationships using instrumental variable analysis or discontinuity design. Future studies can also explore the intersection of other factors (location, technology awareness, and gender) and households' energy decisions.

REFERENCES

Abokyi, E., Appiah-Konadu, P., Oteng-Abayie, E. F., & Tangato, K. F. (2024). Consumption of clean and dirty cooking fuels in Ghanaian households: The role of financial inclusion. Cleaner and Responsible Consumption, 13, 100187.

Ali, E., Yaotse, K., Obeng, E. O. B., Gyamfi, S., Osman, M. S., Adoko, T., & Narra, S. (2024). Determinants of household cooking fuel choices: Does proximity to mine site matter? *Energy for Sustainable Development, 82*, 101545.

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

Ali, J. & Khan, W. (2022). Factors affecting access to clean cooking fuel among rural households during COVID-19 pandemic. *Energy for Sustainable Development,* 67, 102-111,

Aminu, R. O., Dzudzor, M. A., Oyawole, F. P., & Afolayan, S. O. (2024). Understanding the determinants of household cooking-fuel choice in sub-Saharan Africa: evidence from Nigeria. *Clean Energy*, *8*(2), 144-155.

Amuedo-Dorantes, C. (2014). The good and bad of remittances. The good and the bad in remittance flows. IZA World of Labor 2014: 97. doi: 10.15185/izawol.97. https://wol.iza.org/uploads/articles/97/pdfs/good-and-bad-in-remittance-flows.pdf.

Andrade-Rivas, F., Okpani, A. I., Lucumí, D. I., Castillo, M. D., & Karim, M. E. (2024). Epidemiological insights into neonatal deaths: The role of cooking fuel pollution in Colombia. *International Journal of Hygiene and Environmental Health*, *261*, 114429.

Awan, A., Bilgili, F., & Rahut, D. B. (2023). Household fuel choices and consumption intensity in Pakistan: evidence from HIES data 2001–2019. *Environmental Science and Pollution Research*, 1-16.

Barkat, K., Alsamara, M., & Mimouni, K. (2023). Can remittances alleviate energy poverty in developing countries? New evidence from panel data. *Energy Economics*, *119*, 106527.

Basu, A. K., Byambasuren, T., Chau, N. H., & Khanna, N. (2024). Cooking fuel choice and child mortality in India. Journal of Economic Behavior & Organization, 222, 240-265.

Bensch, G., Jeuland, M., & Peters, J. (2021). Efficient biomass cooking in Africa for climate change mitigation and development. *One Earth*, *4*(6), 879-890.

Bisu, D. Y., Kuhe, A., & Iortyer, H. A. (2016). Urban household cooking energy choice: An example of Bauchi metropolis, Nigeria. *Energy, Sustainability and Society*, *6*, 1-12.

Chen, Y., Raza, K., & Alharthi, M. (2023). The nexus between remittances, education, and energy consumption: Evidence from developing countries. *Energy Strategy Reviews*, *46*, 101069.

Choudhuri, P., & Desai, S. (2021). Lack of access to clean fuel and piped water and children's educational outcomes in rural India. *World Development, 145*, 105535.

Djeunankan, R., Njangang, H., Tadadjeu, S., & Kamguia, B. (2023). Remittances and energy poverty: fresh evidence from developing countries. *Utilities Policy*, *81*, 101516.

DMAG (2018). Review of financial transfers and remittance mechanisms in Ghana. https://www.iom.int/sites/g/files/tmzbdl486/files/country/docs/ghana/iom_ghana_remittances_review_final.pdf

Endalew, M., Belay, D. G., Tsega, N. T., Aragaw, F. M., Gashaw, M., & Asratie, M. H. (2022). Household solid fuel use and associated factors in Ethiopia: a multilevel analysis of data from 2016 Ethiopian Demographic and Health Survey. *Environmental Health Insights, 16*, 11786302221095033.

Frostad, J. J., Nguyen, Q. P., Baumann, M. M., Blacker, B. F., Marczak, L. B., Deshpande, A., ... & Kapoor, N (2022). Mapping development and health effects of cooking with solid

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

fuels in low-income and middle- income countries, 2000–18: a geospatial modelling study. *The Lancet Global Health, 10*(10), e1395-e1411.

Ghana Energy Commission (2022). *2022 energy outlook for Ghana*. Ghana Energy Commission. https://energycom.gov.gh/newsite/index.php/planning/sub-codes#

Goldemberg, J., Martinez-Gomez, J., Sagar, A., & Smith, K. R. (2018). Household air pollution, health, and climate change: cleaning the air. *Environmental Research Letters, 13*(3), 030201.

Gould, C. F., & Urpelainen, J. (2018). LPG as a clean cooking fuel: Adoption, use, and impact in rural India. *Energy Policy*, *122*, 395-408.

Gould, C. F., Schlesinger, S. B., Molina, E., Bejarano, M. L., Valarezo, A., & Jack, D. W. (2020). Household fuel mixes in peri-urban and rural Ecuador: Explaining the context of LPG, patterns of continued firewood use, and the challenges of induction cooking. *Energy Policy*, *136*, 111053.

Gould, C. F., Schlesinger, S., Toasa, A. O., Thurber, M., Waters, W. F., Graham, J. P., & Jack, D. W. (2018). Government policy, clean fuel access, and persistent fuel stacking in Ecuador. *Energy for Sustainable Development*, *46*, 111-122.

Gupta, R., & Pelli, M. (2021). Electrification and cooking fuel choice in rural India. *World Development*, *146*, 105539.

Guta, D. (2018). Determinants of household adoption of solar energy technology in rural Ethiopia. *Journal of Cleaner Production*, 204, 193–204.

Guta, D., Baumgartner, J., Jack, D., Carter, E., Shen, G., Orgill-Meyer, J., ... & Zerriffi, H. (2022). A systematic review of household energy transition in low and middle income countries. *Energy Research & Social Science*, *86*, 102463.

Haq, I., Khan M. Chakma S., Hossain, I., Sarkar, S. et al (2024). Determinants of household adoption of clean energy with its rural-urban disparities in Bangladesh. *Scientific Reports*, 14, 1-12

Hassan, Gazi, Clean Energy and Household Remittances in Bangladesh: Evidence from a Natural Experiment (April 16, 2020). CAMA Working Paper No. 33/2020, Available at SSRN: https://ssrn.com/abstract=3577362 or http://dx.doi.org/10.2139/ssrn.3577362

Hosan, S., Rahman, M. M., Karmaker, S. C., Chapman, A. J., & Saha, B. B. (2023). Remittances and multidimensional energy poverty: Evidence from a household survey in Bangladesh. *Energy*, 262, 125326.

Huang, W.-H., 2015. The determinants of household electricity consumption in Taiwan: Evidence from quantile regression. *Energy 87*, 120–133.

International Energy Agency; International Renewable Energy Agency, United Nations Statistics Division, World Bank, & World Health Organization, Tracking SDG 7: The Energy Progress Report 2020, World Bank, 2020. http://hdl.handle.net/10986/33822.

International Monetary Fund (2009). *Balance of payments statistics yearbook*. International Monetary Fund, Washington, DC.

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

Islam, S., Rana, M. J., & Shupler, M. (2023). Deepened socioeconomic inequality in clean cooking fuel use in India from 2005-2006 to 2015–2016. *Heliyon*, *9*(6).

Kovalskyi, M., Duczmal, W., Oleksiuk, M., Skomorovskyi, A., & Berezivskyy, Z. (2024). Renewable Energy Sources in The Context of Emissions Reduction: Geographical Aspects And Challenges for Sustainable Development. African Journal of Applied Research, 10(1), 374-386.

Lukashevych, Y., Evdokimov, V., Polukhin, A., Maksymova, I., & Tsvilii, D. (2024). Innovation In The Energy Sector: The Transition To Renewable Sources As A Strategic Step Towards Sustainable Development. African Journal of Applied Research, 10(1), 43-56.

Mainimo, E. N., Okello, D. M., Mambo, W., & Mugonola, B. (2022). Drivers of household demand for cooking energy: A case of Central Uganda. *Heliyon*, 8(3).

Mishra, K., Kondratjeva, O., & Shively, G. E. (2022). Do remittances reshape household expenditures? Evidence from Nepal. *World Development*, *157*, 105926.

Muller, C., & Yan, H. (2018). Household fuel use in developing countries: Review of theory and evidence. *Energy Economics, 70*, 429-439.

Musah-Surugu, I. J., Ahenkan, A., Bawole, J. N., & Darkwah, S. A. (2017). Migrants' remittances: A complementary source of financing adaptation to climate change at the local level in Ghana. *International Journal of Climate Change Strategies and Management*, *10*(1), 178-196.

Ntegwa, M. J., & Olan'g, L. S. (2024). Explaining the rise of economic and rural-urban inequality in clean cooking fuel use in Tanzania. *Heliyon*, 10(1).

Ochieng, C. A., Zhang, Y., Nyabwa, J. K., Otieno, D. I., & Spillane, C. (2020). Household perspectives on cookstove and fuel stacking: A qualitative study in urban and rural Kenya. *Energy for Sustainable Development, 59*, 151-159.

Odame, M. L., & Amoah, A. (2023). Household exposure to the risk of cooking smoke: Evidence from Sub- Saharan Africa. *Energy Nexus, 12*, 100256.

Ortega, J. T., De La Rosa, J. O., & Tovar, O. W. O. (2024). Computer data analysis: An approach to identify the effect of remittances on household consumption in Latin America (2010-2021). *Procedia Computer Science, 231*, 577-582.

Osei-Gyebi, S. (2023). Does inward remittance influence the choice of cooking fuel? *International Journal of Sustainable Energy*, *42* (1), 1226-1240.

Oyeniran, I. W., & Isola, W. A. (2023). Patterns and determinants of household cooking fuel choice in Nigeria. *Energy, 278*, 127753.

Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS.* Routledge.

Parvizi, K., Menya, D., Nix, E., Mangeni, J., Lorenzetti, F., Sang, E., ... & Shupler, M. (2024). Burden of headaches, eye irritation and respiratory symptoms among females stacking

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

LPG with polluting cooking fuels: Modelling from peri-urban Cameroon, Ghana & Kenya. *Energy Nexus, 14*, 100304.

Perros, T., Allison, A. L., Tomei, J., Aketch, V., & Parikh, P. (2023). Cleaning up the stack: Evaluating a clean cooking fuel stacking intervention in urban Kenya. *Renewable and Sustainable Energy Reviews, 188*, 113900.

Price, M., Barnard-Tallier, M., & Troncoso, K. (2021). Stacked: In their favour? The complexities of fuel stacking and cooking transitions in Cambodia, Myanmar, and Zambia. *Energies, 14*(15), 4457.

Puzzolo, E., & Pope, D (2017). Clean fuels for cooking in developing countries. *Encyclopedia of Sustain*able *Technologies, 4*, 289-297.

Qiu, X., Jin, J., He, R., & Zhang, C. (2023). Do solid fuels for cooking lead to an increased prevalence of respiratory disease? Empirical evidence from rural China. *Energy for Sustainable Development, 74*, 297-308.

Rahut, D. B., Ali, A., Mottaleb, K. A., & Aryal, J. P. (2019). Wealth, education and cooking-fuel choices among rural households in Pakistan. *Energy Strategy Reviews 24*, 236–243.

Rahut, D. B., Aryal, J. P., Chhay, P., & Sonobe, T. (2022). Ethnicity/caste-based social differentiation and the consumption of clean cooking energy in Nepal: An exploration using panel data. *Energy Economics, 112*, 1-13.

Rubinstein, F., Ngahane, B. H. M., Nilsson, M., Esong, M. B., Betang, E., Goura, A. P., ... & Puzzolo, E. (2022). Adoption of electricity for clean cooking in Cameroon: A mixed-methods field evaluation of current cooking practices and scale-up potential. *Energy for Sustainable Development, 71*, 118-131.

Stanistreet, D., Hyseni, L., Puzzolo, E., Higgerson, J., Ronzi, S., Anderson de Cuevas, R., ... & Pope, D. (2019). Barriers and facilitators to the adoption and sustained use of cleaner fuels in Southwest Cameroon: Situating 'lay' knowledge within evidence-based policy and practice. *International Journal of Environmental Research and Public Health, 16*(23), 4702.

Twumasi, M. A., Jiang, Y., Addai, B., Asante, D., Liu, D., & Ding, Z. (2021). Determinants of household choice of cooking energy and the effect of clean cooking energy consumption on household members' health status: The case of rural Ghana. Sustainable Production and Consumption, 28, 484-495.

Wijayarathne, J. S., Hassan, G. M., & Holmes, M. J. (2022). *Migration, remittances and cooking fuel usage in Sri Lanka: The mediating role of household weal*th. University of Waikato.

World Bank (2022). Remittances grow 5% in 2022, despite global headwinds. https://www.worldbank.org/en/news/press-release/2022/11/30/remittances-grow-5-percent-2022#:~:text=Remittances%20to%20Sub%2DSaharan%20 Africa%2C%20

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 91-108
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.05
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 12, 2023
Peer reviewed: June 10, 2024
Revised: October 2 2024
Published: December 2024

Yadav, P., Davies, P. J., & Asumadu-Sarkodie, S. (2021). Fuel choice and tradition: Why fuel stacking and the energy ladder are out of step*? Solar Energy, 214*, 491-501.

Yang, K., & Chen, R. (2024). Association between cooking fuel exposure and respiratory health: Longitudinal evidence from the China Health and Retirement Longitudinal Study (CHARLS). Ecotoxicology and Environmental Safety, 275, 116247.

Yunusa, S. U., Mensah, E., Preko, K., Narra, S., Saleh, A., & Sanfo, S. (2024). Assessing the nexus between household dynamics and cooking energy choice: evidence from Kaduna state, northwestern Nigeria. *Energy Nexus*, 100310.

ISSN: 2408-7920