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What Drives Household Electricity Choice? Evidence from Northern Ghana

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Compared to urban areas, a satellite picture of rural areas at night is distressing. Bright lights are few and far between yet in the face of the Strategic National Energy Plan, Sustainable Energy for All Action Plan, the Ghana Energy Development and Access Project and Energy Sector Strategy and Development Plan is the energy sector vision which advocates for accessible energy for all households in Ghana. This paper investigates the factors that influence households' choice of modern electricity in the West Mamprusi District of Ghana using a household survey data. Multi-stage sampling procedure was used to obtain 295 households for the study. The underlying empirical model was estimated using the Probit model. Contrary to widely held beliefs, the results of the Probit model revealed that cattle ownership which is a proxy for wealth/income is not a key determinant of household energy connectivity. Significant and positive variables included tenancy type, radio, TV and fridge ownership, perception about electricity, duration and cost of use of electricity. Government can support the development of alternative energy sources such as renewable energy or promote the entry of multiple players into the generation market to reduce the cost of supplying utility power to the rural communities, thus enabling affordability by every household.

Key words: Connectivity, modern electricity, Probit model, Ghana

INTRODUCTION

Energy is one of the key drivers of any economic growth and development. Approximately 2.5 billion people in developing countries use biomass as cooking fuels. Without new policies and implementation strategies aimed at reducing the reliance on biomass fuels, this number is expected to increase by 1 and 2 billion by 2015 and 2030 respectively (IEA, 2006). While majority of all households in sub-Saharan Africa use fuel-wood, charcoal or wood waste as cooking fuels, rural households often rely heavily on biomass fuels than those in urban areas (IEA, 2006). According to the Ghana living Standard Survey 5 conducted by GSS (2008), over 50% of households in Ghana rely on both traditional and non-traditional energy. About 79% of households in urban areas have electricity for lighting as against 27% of households in rural areas. Electricity and kerosene are the main sources of energy for lighting in

Ghana. Specifically, about 49.3% still use kerosene with households in rural areas forming the majority (72%). However, of the 49.2% using electricity as main source of light, 79% of these households are in urban areas. There are some notable disparities regarding what constitutes the main sources of cooking fuels across the rural – urban divide although majority of households rely on wood (53.5%) and charcoal (30.6%). For instance, 57% of households in urban areas rely on charcoal relative to 14% in rural areas. However, the main source of cooking fuels in rural areas is wood where about 80% of rural folks cut down trees to use as cooking fuels as opposed to 19% in urban areas.

Electricity and kerosene usage as cooking fuels is low in both areas where 0.5% and 0.1% of households in urban and rural areas respectively rely on electricity to prepare food and heating water. Further results from the

survey reveal that while about 1.2% and 0.2% of urban and rural households respectively use kerosene, 20% and 1.5% of households in urban and rural areas rely on gas respectively.

World Health Organization (WHO) argues that household energy systems in developing economies undoubtedly contribute immensely to climate change compared to those in developed economies (WHO, 2011). There is thus a global call on the adoption and use of efficient and clean fuels in order to mitigate the negative consequences on the ecology, health and social impacts (Lewis and Pattanayak 2012; Miah et al. 2011; Duflo et al. 2008; Akpalu et al. 2011; Sagar and Kartha 2007)

In addition to increasing the national electricity gridlines across the country, Government has over the years made efforts in subsidizing Liquefied Petroleum Gas (LPG) for home use in order to reduce the overreliance of wood and charcoal as well conserve the natural vegetation. Mindful of the fact that over dependence on the few natural resources for energy and livelihood could present environmental and natural resource depletion and hence a major obstacle to fulfilling Ghana's growth and development potential, the Ghana's energy policies seek to ensure high quality and reliable power supply to all sectors of the economy (Strategic National Energy Plan, 2006; MoE, 2010). Ghana's development policies such as GPRS I and II, the current policy regime "Ghana Shared Growth and Development Agenda" (GSGDA) as well as the Strategic National Energy Plan and the National Energy Policy priority are all some of the key development policy documents that give clear and high priority to energy development and increased access to modern energy sources as essential inputs for rapid socio-economic development and poverty alleviation. Despite all these policy documents, the energy sector is plagued with a number of serious challenges and these include inadequate access to the national electricity grid. For instance, as at 2005, about 53% of the Ghanaian population of whom 83% are rural dwellers has no access to electricity. Electricity and petroleum account for 12% and 23% respectively and biomass (wood fuel and charcoal) alone accounts for 65% of the total energy supply. Also, a survey conducted in 2012 by SNV Ghana on energy situation show that access to clean modern energy in Central Gonja District is very low as 2.3% of the 256 towns and villages were connected to electricity from the national grid with the rest of the population in the area using different systems for household lighting (SNV-Ghana, 2012).

In West Mampurisi District, a survey conducted by SNV-Ghana on 206 respondents (from household Micro, Small and Medium Enterprises and institutions) revealed that 32.1% were connected to electricity from the national grid.

Rural Electrification was initiated in Ghana in 1970 to bring electrification to rural areas and help bridge the urban-rural inequality gap and increase economic activity in the rural areas. About 70 communities benefited from the installation at the onset with the beneficiary communities contributing about 1% of the capital cost. In 1989, Rural Electrification Policy (REP) was replaced by the National Electrification Scheme (NES). The main Goal of NES was to achieve universal access of reliable electricity supply to all communities over a 30-year period (1990-2020) and to reduce level of poverty nationwide, particularly in the rural areas through employment creation and productivity increment.

Subsequently, 25% was recorded as the national electrification access. By then, 41.8% out of the 110 district capitals existing were connected to the grid while less than 5% was estimated as the rural coverage. The introduction of the policy gave way to the National Electrification Levy which was instituted to support the implementation of the rural electrification programme. In the course of achieving universal access of electricity for all communities, Self-Help Electrification Programme (SHEP) was instituted to support the acceleration of the connection of communities to the national electricity grid. Other energy plans that were documented to guide the sector included the Strategic National Energy Plan (SNEP), Sustainable Energy for All Action Plan, the Ghana Energy Development and Access Project (GEDAP), Energy Sector Strategy and Development Plan (ESSDP) and the Vision 2020. Currently, the Rural Electrification project is managed and implemented by the Ministry of Energy but designed and supervised by local consultants, constructed by local and foreign contractors with funding from National Electrification Levy (NEL) and others.

Koswari and Zeriffi (2011) argues that intervention programmes by governments have had mixed results on the energy choice behaviour of households and rarely manage to effectively target the population the intervention was meant for. Designing projects and policies for promotion of energy services depends on the understanding of the key factors affecting household connectivity. However, few systematic empirical efforts have been done in examining the factors influencing households' decision to connect to electricity.

Most insights on fuel choice take credence to empirical studies in investigating the determinants of household fuel choice vis-à-vis testing the energy ladder hypothesis using income. It is however worth noting that the determinants and proxies in these studies are examined with disregard to area-specifics and context. This paper bridges part of the gap in literature through its usage of a unique income proxy – cattle ownership. This stems from the fact that in a typical Northern rural setting in Ghana, household's income are often measured by

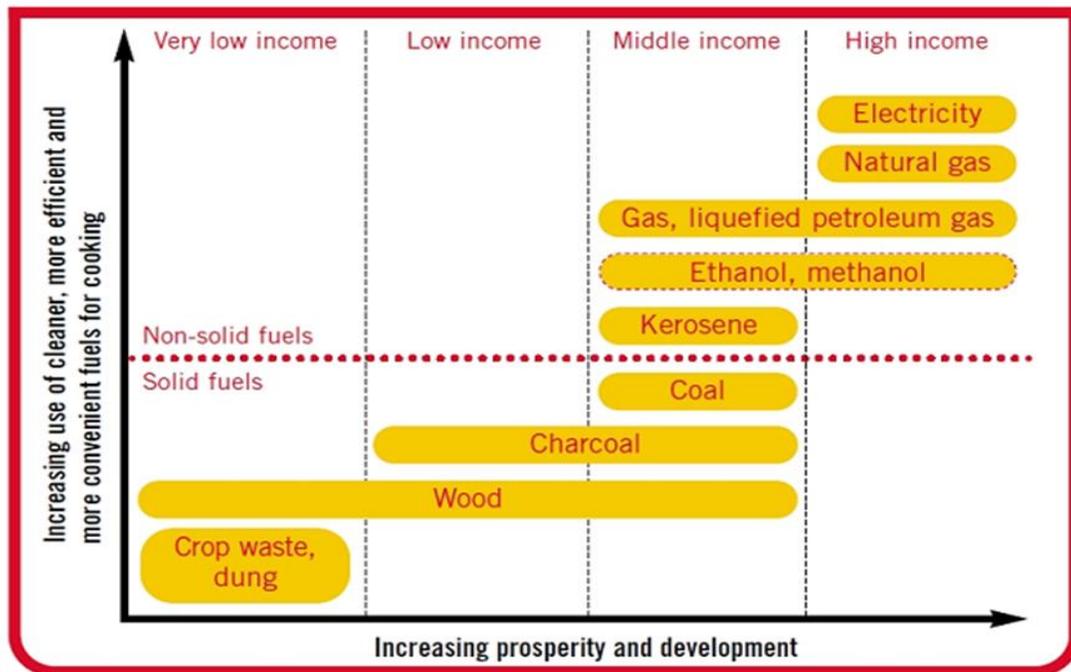


Figure 1: Energy ladder hypothesis

Source: Rehfuess, 2006

whether or not a household has cattle. To the best of our knowledge, this is the first study in Ghana that attempts to put the energy ladder hypothesis into test using such a proxy. We focus our analysis on household energy connectivity to national grid. This investigation is not only crucial given the role of electricity in household energy use and economic growth at large but also as to identify significant factors that propel the workings toward the achievement of the objectives of the rural electrification project. Studies on the determinants of household fuel choice in Ghana are few and results from the scanty studies are mixed and inconclusive necessitating nuanced further research. The aim of this paper is to investigate the factors influencing household choice to electricity connection from the national grid.

Results from study reveal that about 50% of households are connected to electricity and decision to choose clean and efficient fuel is significantly determined by dwelling status, access to credit, income, membership to association/group, distance to Volta River Authority (VRA) sub-office, perception of hazardous nature of electricity, duration and cost of electricity, cattle ownership and usage of such electrical appliances including radio, television and fridge.

The rest of the paper is organized as follows: Section 2 provides theoretical underpinnings and review of literature; Section 3 outlines our empirical strategy; results and discussions are presented in Section 4 while Section 5 concludes the study with some recommenda-

tions for policy.

Literature review

The energy ladder hypothesis provides the theoretical justification for a representative household to switch to modern energy source as income increases. This hypothesis is built on the assumption that a household's fuel choice is dependent on the level of income such that as incomes increase, households move from the traditional fuels, such as wood, first to transitional fuels, like kerosene and charcoal, and then to modern fuels, such as electricity from the grid (Leach, 1992). Thus, households with low income levels heavily rely on biomass fuels (often dirtier) while those with relatively higher incomes consume electric energy often cleaner and more expensive (Heltberg, 2005). This dynamic is well illustrated in Figure 1.

Critics (Masera et al. 2000; Heltberg, 2004) however argue that the energy ladder provides only limited and restrictive view owing to its failure to adequately show the dynamics in household fuel choice. To them, the possibility of multiple fuel choices provides an elaborated and better alternative. In other words, each household faces a number of mutually exclusive options of cooking fuels and thus chooses the one that best maximizes its utility. Hence, the likelihood of fuel stacking provides a kind of "cross-sectional energy ladder" (Lay et al. 2012)

where instead of smoothly switching from traditional energy source to modern, households only partially adopt to improved and efficient energy source while continually relying on traditional fuels for performing specific tasks. In the case of Northern Ghana, major households maintain improved energy and charcoal/firewood as cooking fuels. However, the latter energy sources are often reserved for cooking some traditional staple food such as *tou zaafi* (See also Mensah and Adu (2013) for similar argument.). In a typical rural setting in Northern Ghana where households' socio-economic characteristics are by far homogenous, a household choosing a relatively more expensive energy source is often thought to signal higher social status hence a move up the energy ladder typically portray an increase in social status.

Heltberg (2004) investigates fuel switching in urban areas for eight developing countries including Ghana. Results from his study show a strong link between electrification and the adoption of modern cooking fuels. Other factors that are associated with an increased probability of using modern fuels include consumption expenditure, education and household size. Heltberg's (2005) subsequent study in Guatemala corroborates with the significance of income in influencing household fuel choice. While cost of firewood is also a crucial determinant of energy choice, Heltberg's (2005) results reveal a widespread prevalence of fuel stacking for cooking purposes in Guatemala and therefore explicitly incorporates two-fuel options in the empirical analysis.

Multinomial logit model estimation results of Couture et al. (2010) study on the household energy choices and fuelwood consumption in France shows that choice for fuel usage is mainly driven by income. In particular, with the exception of the choice for wood as a main energy, income is positively related to electricity, gas and fuel oil as main energy sources. The implication is that a low income raises the probability of using wood as main energy. Conversely, an increase in household income increases the likelihood of choosing cleaner fuels and the more inclined they are to using wood as back-up source of heating. Further evidence reveal that while household size positively (and significantly) influences the probability of choosing wood as main energy, it negatively affects the probability of opting for cleaner fuels as main energy although the latter effect is not statistically different from zero. Couture et al. (2010) also found that if household owns its main residence, then with the exception of choosing gas as main energy, the likelihood of choosing wood, electricity and fuel oil is higher. However, only the probability of using wood is significant.

By using a multinomial logit model in investigating the determinants of household cooking fuel choices, Njong and Johannes (2011) note that while firewood is the

principal cooking fuel for majority of households in Cameroon particularly those in rural areas and Northern regions, level of education, proximity of household to urban centers, residential status of household and the type of housing structure (whether traditional or modern) are important determinants of households' cooking fuel choice.

By employing the random effects logit to determining the decision to use fuel type in Ethiopia, (They used charcoal, electricity, wood and kerosene.) Mekonnen and Köhlin (2008) find that while the coefficients of own prices of wood and electricity are insignificant, a negative and significant estimates of own prices for charcoal and kerosene implying that the probability of consuming these fuel types fall as their prices increase. However, with the exception of charcoal and electricity which are found to be complements, the cross-price coefficients generally show some degree of substitution between the fuel types. Further results reveal that larger households are more likely to consume wood and charcoal and less likely to use kerosene. An intra-household gender disparity shows that while households with larger women have higher likelihood of using charcoal, the probability of opting for charcoal and the other fuel types are mutually exclusive. On the other hand, a typical household with a member obtaining at least secondary education has a higher likelihood of using non-solid fuels (electricity and kerosene) and the probability that such household consume wood is lower. This evidence suggests the importance of education in influencing household choice for cleaner fuels. Their findings generally find support for fuel stacking in describing fuel choice behavior of households in developing countries.

Lay et al. (2012) replicated Mekonnen and Köhlin's (2008) approach and applied to Kenya data by limiting household fuel choice to wood, kerosene, electricity, solar and dry cells. Their results generally found support for the energy ladder hypothesis where households' practically switch from wood to kerosene to electricity or solar when their income levels increase. This finding is however inconsistent with Mekonnen and Köhlin (2008). Further results from Lay et al. (2012) reveal that households begin to use modern fuels only after attaining additional higher education. However, living in a flat decreases the probability of using wood or kerosene. These results do not change even after controlling for household size. They however found a positive and significant relationship between the choice for wood and household size as well an inverse relationship between electricity and solar; and household size.

More recently, Nlom and Karimov (2014) employed the ordered probit model to explore the socio-economic and demographic factors that affects household fuel choice in Northern Cameroon. Consistent with Lay et al. (2012),

their results show a positive and significant effect of income and education in influencing household decision to adopt clean fuels. Akin to Nlom and Karimov (2014) found that living in traditional houses increases the desire of choosing cleaner fuels. This is however inconsistent with Lay et al. (2012). Interestingly, a household head working in a paid job negatively affects the probability of choosing cleaner fuels albeit insignificantly.

By using the logit model to examine the factors influencing households' decision to use wood-based biomass fuel for cooking purposes in Upper West region of Ghana, Kuunibe et al. (2013) found that household size, price of wood, income and level of education negatively and significantly influence choice for dirtier fuel. This finding is consistent with the energy ladder hypothesis as well akin to Mekonnen and Köhlin (2008), Njong and Johannes (2011) and Heltberg (2003).

Kwakwa et al. (2013) employs the logit regression model to determine the factors influencing household energy choice. Contrary to their hypothesis, Kwakwa et al.'s (2013) study reveals an inverse and significant relationship between household income, education and the probability of choosing electricity as main energy. This is however inconsistent with the energy and "educational" ladder hypotheses. Formal sector employment and family size appear to negatively affect the choice for cleaner fuels although both effects are insignificant. Further evidence shows that kerosene usage and living in rural communities also exert negative and significant impact on household probability of opting for electricity. The implication is that access to kerosene is associated with lower incidence of electricity consumption – an indication that electricity and kerosene are substitutes.

More recently, Mensah and Adu (2013) used the ordered probit model in investigating the determinants of household cooking energy choices by relying on nationwide household survey data. Results from their study confirm the energy ladder hypothesis. Although this sharply contradict Kwakwa et al. (2013), Mensah and Adu's (2013) finding is consistent with Kuunibe et al. (2013), Mekonnen and Köhlin (2008); and Njong and Johannes (2011). Anecdotal evidence suggests that household size, age of household head and unreliable supply of charcoal have significant negative effects on the likelihood of choosing clean and efficient fuels. Consistent with Mekonnen and Köhlin (2008) further results show a direct and significant impact of education on the probability of a household moving from inefficient and dirtier energy source to modern and efficient fuels.

It is imperative to note that extant studies (Mensah and Adu, 2013; Nlom and Karimov, 2014; Suliman, 2010; Osiolo, 2009) on household fuel choice mostly rely on national household surveys and case studies, our current study uses smaller surveys as a way of bringing

to bear factors often left undetected in large household surveys.

METHODOLOGY

Study area and data collection methods

West Mamprusi District is one of the administrative districts in the Northern Region of Ghana. Walewale is the district capital harbouring 12% of the District's population. It is located roughly within longitude $0^{\circ}35'W$ and $1^{\circ}45'W$ and latitude $9^{\circ}55'N$ and $10^{\circ}35'N$ with a total area of $5,013\text{Km}^2$. Sharing boundaries with Mamprusi East, Gushegu, Tolon/Kumbungu, Savelegu/Nanton, Karaga, Builsa, Kassena-Nankana, Talensi/Nabdam, Sissala and Wa west, the District lies within the Northern Region and has strong economic and functional linkages with some major settlements in the Upper East Region such as Bolgatanga and Fumbisi. The vegetation which is annually affected by bush fires, which sweep across the savannah woodland each year has an implication for household connectivity to electricity from the natural grid. A map representing vegetative zones is shown below in Figure 2.

Gathering information for the study, we explored various data gathering techniques at several levels: predominantly at the household level, at the institutional level (both public and private sector) facilities which are community based and micro, small and medium scale enterprises using structured questionnaires. Purposive sampling technique was used for the identification of stakeholders and the selection of the 7 area councils. This was found to be useful since it was clear by all stakeholders that energy issues vary from area council to another. More so, this arrangement was the administrative system used by the district assembly. The area councils were created based on spatial distribution and level of economic and social development for revenue generation. A system of classification of communities developed by the district assembly to classify communities according to area council for administrative purposes was adopted. All communities within an area council were given equal chance of being selected. In all, a total of households 210, 42 micro, small and medium enterprises and 43 institutions were selected resulting in a sample size of 295.

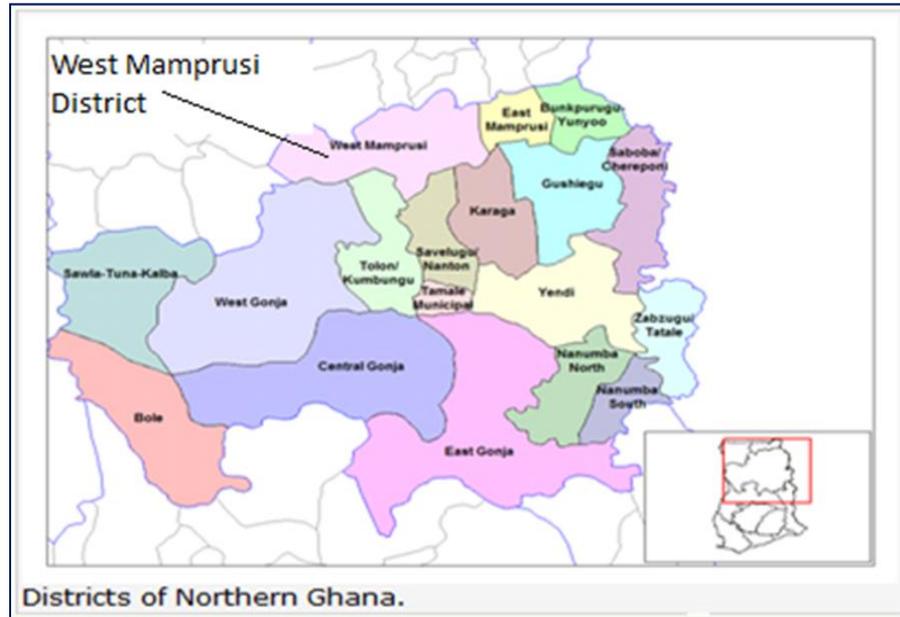


Figure 2: West Mamprusi District Map.

Source: SNV-Ghana, 2012

Model specification

Response to the use of electricity from the national grid as energy choice was recorded as a binary variable represented by 1 if connected or 0 if not connected. In other words households’ connectivity to electricity was expressed in two categories: “connected” and “not connected”, thus placing the analysis within the framework of binary choice models. Models for explaining a binary dependent variable include the linear probability model (LPM), probit and logit models (Maddala, 1992; Greene, 2003 and Gujarati, 2004). However, since the dependent variable is dichotomous, the use of LPM is not appropriate because the predicted value can fall outside the relevant probability range of 0 and 1. Aside this, it is also reported to have non-normal and non-constant error terms and posses constant effect of the explanatory variable. To overcome these problems, logit or probit models have been recommended. These models have been argued to have similar estimates (see Maddala 1992; Greene 2003; Gujarati, 2004; Hill et al. 2008).

Logit and probit models translate the values of the independent variables (X_i), which may range from $-\infty$ to $+\infty$ into a probability for (Y_i) which ranges from “0” to “1” and compel the disturbance terms to be homoscedastic. The forms of probability functions depend on the distribution of the difference between the error terms associated with a particular choice. The probit and logit models assume the existence of an underlying latent variable for which a dichotomous

realization is observed (Gujarati, 2004), thus given the model:

$$Y_i^* = \beta_0 + \sum_{j=1}^k \beta_j X_{ij} + \varepsilon_i \dots \dots \dots (1)$$

where Y_i^* is a latent variable (not observable) and what is observed is a dummy variable Y_i defined as:

$$\begin{cases} 1 & \text{if } Y_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \dots \dots \dots (2)$$

In order to estimate the probabilities of households’ connectivity or non-connectivity of electricity to the national grid, this study uses the probit model since the results are similar with logit. The model is specified as:

$$Y_i = X_i' \beta + \varepsilon_i \dots \dots \dots (3)$$

where Y_i is household connectivity and a latent variable which can be related to the observable binary variable Y_i through the expression:

$$Y_i = \begin{cases} 1 & \text{if } Y_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \dots \dots \dots (4)$$

where X_i as a vector of explanatory variables consist of gender, education, household size, tenancy type, credit, membership to association, contacts with VRA workers, distance to VRA sub-office, cattle (proxy of income), type of electrical gadget (radio, phone, TV and fridge), household perception of electricity, duration of use, cost of use and perception of the hazard involve; β is the vector of unknown parameter estimates and the ε_i is the stochastic error term assumed to be normally distributed.

Table 1: Definition, measurement and sample average of variables included in the model

Variable	Definition/measurement	Mean	S. D.
Household connectivity	Dummy (1 = connected to electricity; 0 otherwise)	0.4983	0.5008
Gender	Dummy (1 = male; 0 otherwise)	0.6644	0.4730
Education	Dummy (1 = formal education; 0 otherwise)	0.1492	0.3568
Household size	Number of people in the household	8.9017	5.9052
Household dwelling status	Dummy (1 = rented; 0 otherwise)	0.2034	0.4032
Credit	Dummy (1 = household has access to credit; 0 if otherwise)	0.0339	0.1813
Group membership	Dummy (1 = member of a group; 0 otherwise)	0.4169	0.4939
Contacts with VRA workers	Dummy (1 = contacts with VRA workers; 0 otherwise)	0.7322	0.4436
Distance to VRA or town	Dummy (1 = far from VRA sub-office/town; 0 otherwise)	0.0441	0.2056
Cattle	Dummy (1 = household has cattle; 0 otherwise)	0.3627	0.4816
Radio	Dummy (1 = household has radio; 0 otherwise)	0.1898	0.3928
Phone	Dummy (1 = household has phone; 0 otherwise)	0.8644	0.3429
TV	Dummy (1 = household has TV; 0 otherwise)	0.4407	0.4973
Fridge	Dummy (1 = household has a fridge; 0 otherwise)	0.2000	0.4007
Perception	Dummy (1 = electricity is reliable; 0 otherwise)	0.1763	0.3817
Duration of use	Number of hours	15.5444	12.6803
Cost of use	Amount in Ghana Cedis (GH¢)	11.9939	30.9158
Hazard	Dummy (1 = electricity is hazardous; 0 otherwise)	0.5627	0.4969

Source: Authors' computation, 2014

RESULTS AND DISCUSSIONS

The description and measurement of the variables used in the model are presented in the Table 1. The choice of these variables is based on literature (Gangopadhyay et al. 2003; Ouedraogo, 2006; Bello, 2011; Kwakwa et al. 2013) since they play key roles in household energy choice. Results from study reveal that about 50% of household are connected to the national grid where male household comprised of 66% of the sample. The average household size is 9 while 20% lives in rented houses/rooms. Further findings show a rather low educational level among households. Volta River Authority (VRA) through its technical workers has the mandate of connecting and extending electricity to areas and households willing to pay. They also fix electricity problem households face as well educates the latter on the need and how to use electricity as an energy source. As such, about 73% of household have had contacts with VRA workers while 4% perceive the distance to VRA sub-office far.

Turning to our major variable of interest, the results reveal that about 36% of households have cattle – an indicator of wealth/income. On the ownership of electrical appliances and usage of electricity, our findings suggest that about 20%, 44% and 19% own fridge, telephone and radio respectively. On the other hand, 86% of the household use phones. The rather high mobile phone user rate is unsurprising given the

high proliferation of mobile telephony in rural areas. The average electricity usage is about 15.5 hours and this costs GH¢12 (US\$3.87) Exchange rate is US\$1=GH¢3.1 to a typical household. However, while 18% view electricity supply to be reliable, about 56% of households perceive electricity as hazardous.

Factors influencing households' connectivity to electricity from the national grid

Results from the probit model estimation for household energy connectivity are presented in Table 2. The model estimation reveals a MacFadden R^2 of 0.6195 showing that the variables included in the model are able to explain about 62% of the probability of households' decisions to connect to modern electricity. There exists problematic multicollinearity if the variance inflation factor (VIF) exceeds 10 (Gujarati, 2004). Our computed VIF of 2.63 shows the absence of collinearity in the model. The MacFadden chi-square value of 253.37 is statistically significant at 1% indicating that all the explanatory variables jointly influence households' probability of connecting to modern electricity. While gender, household size and the hazardous nature of electricity negatively influence household choice for electricity, education, contacts with VRA workers and ownership of a mobile phone positively affect the probability of connecting electricity from the national grid.

Table 2: Maximum Likelihood Estimation of the Determinants of Households' Energy Connectivity

Variable	Coefficient	Standard Error	Z
Constant	-1.3817	0.5339	-2.59
Gender	-0.3396	0.2621	-1.30
Education	0.0024	0.4634	0.01
Household size	-0.0049	0.0217	-0.22
Household dwelling status	1.0740	0.4009	2.68***
Credit	-1.2854	0.6347	-2.03**
Group membership	-0.5421	0.2851	-1.90**
Contacts with VRA workers	0.0052	0.3326	0.02
Distance to VRA sub-office	1.1368	0.5869	1.94*
Cattle	-0.5452	0.2719	-2.00**
Radio	0.9173	0.3033	3.02***
Phone	0.0574	0.3320	0.17
Television (TV)	0.8829	0.2948	2.99***
Fridge	1.2813	0.6032	2.12**
Perception	1.7890	0.4969	3.60***
Duration of use	0.0940	0.0166	5.65***
Cost of use	-0.0193	0.0099	-1.95*
Hazard	-0.2868	0.2484	-1.15
Number of observations		295	
LR χ^2 (17)		253.37	
Prob > χ^2		0.000***	
MacFadden R ²		0.6195	
Log Likelihood		-77.7939	

*, **, *** denote significance at 1, 5 and 10% respectively.

Source: Authors' computation, 2014

However, none of these effects is significant. Instead, decision to connect to electricity is significantly determined by dwelling status, credit, membership to a self-help group or association, distance to VRA sub-office, cattle, radio, TV and fridge ownership, perception of electricity, duration and cost of use of electricity.

The results reveal that household dwelling status has positive and significant effects on the probability of connecting to electricity. The implication is that households living in rented houses/rooms have a higher likelihood of consuming cleaner energy than those not renting. The family system in the study area is largely extended with majority of the family members living in the same compound. To the extent that tenants are not usually part of the family he/she resides with, they are therefore expected to connect to electricity for other purposes including cooking fuels since low or no storage space is left for a tenant to store charcoal or firewood. This finding is consistent with Mensah and Adu (2013).

Access to charcoal/firewood is often cheaper, reliably sold in between houses. It was therefore expected that households may consider distance to VRA sub-office as an additional cost to the market fuel price hence putting a negative impact on the probability of connecting to the

national grid. Contrary to our expectations, we found a positive and significant effect of distance on the probability of adopting electricity as the main energy source. In other words, households far away from VRA sub-office or town centre are more likely to connect to the national grid. This means that when costs of obtaining charcoal/firewood and expected utility derived are discounted over its entire lifetime and compared to that of electricity, households are better-off choosing using modern fuel (This assumes rational households.).

Income as proxied by whether or not a household has cattle is found to significantly influence the choice of clean and efficient energy source. In particular, income has a negative effect on the probability of connecting to electricity suggesting that the likelihood of connecting to electricity falls as household income increases. This is true at least within the study although inconsistent with the energy ladder hypothesis, Mensah and Adu (2013), Mekonnen and Köhlin's (2008), it nonetheless confirms Kwakwa et al. (2013). Our finding is confirmed by the access to credit – electricity connection nexus. It is imperative to note that the effect of income on choice of improved fuels may be misunderstood if the impact of access to credit is omitted. For instance, access to

credit, owing to its effect on the ability of the household to finance the purchase of a gas stove, play a significant role in determining the quantity and type of fuel consumed (Edwards and Langpap, 2005; Lewis and Pattanayak, 2012). Our study however reveals that access to credit negatively influences the probability of connecting to electricity from the national grid. This effect is significant and indicative that access to credit puts a depressing effect on the adoption and consumption of clean fuels. This finding may appear counterintuitive because access to credit could increase households' ability to purchase modern fuel thus playing a crucial role in influencing fuel choice. Our study however reveals that access to credit negatively influences the probability of connecting to electricity from the national grid. This effect is significant and indicative that access to credit puts a depressing effect on the adoption and consumption of clean fuels. Although this finding is inconsistent with earlier studies (see for instance Edwards and Langpap, 2005; Lewis and Pattanayak, 2012) who found consumption of clean fuels to increase in response to increases in income via credit. Our results suggest that either households in the study view electricity as an inferior good or the rather inverse relationship between the probability of connecting to electricity (cleaner fuels) and income could be attributed to the erratic power supply that has plagued the country thus discouraging individuals from connecting to electricity. This undoubtedly necessitates households to remain glued to charcoal/firewood and/or find alternative energy source often dirtier even as income levels increase.

Consistent with our expectation, possession of electronic gadgets such as radio, TV and fridge are positively and significantly (at conventional levels) related to electricity connection. This is unsurprising because the use of these gadgets require electricity hence households in possession of these appliances are therefore expected connected to modern electricity. Households who perceive the electricity supply to be reliable have relatively higher probability of connecting to the grid. This effect is significant at 1% and consistent with Mensah and Adu (2013) who found that households with reliable access to LPG were found to adopt cleaner fuels than households without access to LPG. The coefficient of duration is positive and significant as well indicating that higher number of hours power lasts is associated with higher probability of connecting to modern electricity. This could be taken to imply reliability of energy supply thus the probability of choosing efficient fuels is higher when access to the energy is reliable.

Consistent with our a priori expectation is that higher cost of electricity is associated with reduced probability of connectivity. This effect is significant at 10% and implies that the more expensive it is to adopt modern and efficient energy, the lower its usage. Thus higher

expenditure on clean fuel deters households from its consumption. This finding is particularly akin to Mekonnen and Köhlin (2008). Study by Schlag and Zuzarte (2008) show also that high fuel prices hence higher expenditure on energy make households more likely to use traditional fuels than modern fuels.

Kempson and Finney (2009) note that majority of indigenes in developing countries save, and that poor people often rely on informal savings methods. Self-help groups in the study area are often formed with the sole motive embarking on rotating savings schemes where members contribute to a pot and given to another as a lump sum. This is repeated until all members receive the pot and the vicious cycle continuous. Results from our study suggest that the effect of membership to such groups has a negative and significant effect on the choice of energy source where the probability of connecting to electricity is low for household belonging to such groups. To the extent that a member receives a lump sum, this finding is somewhat consistent with our finding on the income – electricity choice nexus.

CONCLUSIONS AND RECOMMENDATIONS

While noting the potential role of energy in driving economic growth via fueling industries and households, the source of energy could also have deleterious effect on the climate hence a drag on growth rates. There is thus a global concern on the need to adopt clean and efficient fuels as the main sources of energy. Ghana through its policy initiatives implemented the rural electrification project as a way of discouraging rural folks on their dependence on solid fuels and connecting to electricity. Using a household survey data, this paper examined the factors influencing households' choice of electricity in the West Mamprusi District of Northern Ghana by employing the Probit model. Results from study show that about 50% of households are connected to the national grid and decision to choose clean and efficient fuel is positively and significantly determine by dwelling status, distance to Volta River Authority (VRA) sub-office, perception and duration of power reliability as well ownership electrical appliances. The study do not find support for the energy ladder hypothesis and connectivity to clean fuel is negatively affected by income, perception of hazardous nature of electricity, access to credit and household membership to self-help groups. We therefore call for the development of alternative, reliable and affordable energy supply as well promote the entry of multiple players into the generation market to make it competitive. District Assemblies can also be encouraged to provide electricity services to their off-grid communities via mini-grids and micro-grids through alternative distributed generation sources. Finally, there must be conscious efforts to intensify

education especially in rural communities and must not only be on the need to adopt clean fuels but also on how to use electricity. This will go a long way to deluding the widely held perception of rural folks on the dangers of using electricity.

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