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Alhassan A. Karakara
School of Economics, University of Cape Coast, Ghana
E-mails: wakeel.kara@gmail.com, abdul-wakeel.alhassan@stu.ucc.edu.gh

Evans S. Osabuohien
Chair, Centre for Economic Policy & Development Research (CEPDeR),
Chair, Regional Centre of Expertise, Ogun. (RCE Ogun),
Covenant University, Ota, Nigeria.
E-mail: evans.osabuohien@covenantuniversity.edu.ng

Simplice A. Asongu
Department of Economics, University of South Africa.
P. O. Box 392, UNISA 0003, Pretoria, South Africa.
E-mails: asongusimplice@yahoo.com / asongus@afridev.org

Research Department

Domestic Energy Consumption in Ghana: Deprivation versus Likelihood of Access

Alhassan A. Karakara, Evans S. Osabuohien & Simplice A. Asongu

January 2021

Abstract

Purpose – This paper analyses the extent to which households are deprived (or otherwise) of clean energy sources in Ghana.

Design/methodology/approach – It engages the Ghana Demographic and Health Survey data (GDHS VI). Three different energy deprivation indicators were estimated: cooking fuel deprivation, lighting deprivation and indoor air pollution. The empirical evidence is based on logit regressions that explain whether households are deprived or not.

Findings – The results show that energy deprivation or access is contingent on the area of residence. Energy access and deprivation in Ghana show some regional disparities, even though across every region, the majority of households use three fuel types: Liquefied Petroleum Gas (LPG), charcoal and wood cut. Increases in wealth and education lead to reduction in the likelihood of being energy deprived. Thus, efforts should be geared towards policies that will ensure households having access to clean fuels to reduce the attendant deprivations and corresponding effects of using dangerous or dirty fuels.

Originality/value – This study complements the extant literature by analysing the extent to which households are deprived (or otherwise) of clean energy sources in Ghana.

Keywords: Energy deprivation, Ghana, Households, Sustainable development

JEL Codes: O13, P28, Q42

1. Introduction

Two reasons motivated this study. First, to achieve Goal 7 of the United Nations' Sustainable Development Goals (SDGs), which is to "*ensure access to affordable, reliable, sustainable and modern energy*", there is the need to look at the pattern and extent to which households are deprived (or otherwise) of clean fuels[1]. Second, to the best of our knowledge, not many studies have focused on energy deprivation using an econometric estimation, particularly in West Africa.

Many households across the globe have limited access to clean fuels. Some 2.4 billion people in the world are estimated to continue to rely on traditional biomass for their energy needs (Saghir, 2005). These people will be exposed to indoor air pollution and the risk of diseases it carries such as respiratory problems. The United Nations Development Programme-UNDP estimated that some 4% to 5% of global diseases result from indoor air pollution (UNDP, 2004). Rafindadi and Usman (2019) suggested that the increase in pollutant emissions is attributed to the use of energy, which is mostly sourced from fossil fuels. Being deprived of clean energy for home use can lead to poverty. Poverty is now considered multidimensional as deprivation of basic needs including energy is an indication of being poor and at risk (Alkire & Santos, 2010; Amoo *et al.*, 2018; Asongu *et al.,* 2018; Karakara & Dasmani, 2019).

It is relevant to articulate that the deprivation in social amenities (which is not necessarily linked to income deprivation) such as room availability, access to electricity, *inter alia*, represent significant determinants of poverty in both urban and rural areas (Alkire & Santos, 2010). Households can be acknowledged as poor if they lack fundamental life-sustaining needs. In the literature focusing on energy and poverty, when a household (or an individual) is using traditional energy sources or is deprived of energy sources that are modern, the attendant household and/or individual is considered to be poor (Karakara & Osabuohien, 2020; Karakara & Dasmani, 2019; Nussbaumer *et al.,* 2012; Nussnaumer *et al.,*2011; World Economic Forum, 2010). A substantial bulk of the literature on the nexus between poverty and energy has focused on household energy expenditures by, *inter alia*, examining the share of household income energy expenditure and corresponding implications on the welfare of the attendant household (Aitken, 2007; Faisal *et al.*, 2013; Ismael, 2015). Another aspect of the energy consumption literature dwelled on the larger scale or macro determinants of energy consumption (Rafindadi &

[1]The words energy and fuel are use interchangeable in this paper. This is because in the attendant literature both terms refer to same thing especially on household consumption for domestic use.

Ozturk, 2015; Azam *et al.,* 2016; Rafindadi, 2016; Cabeza *et al.,* 2018). These studies looked at the global or national level determinants of energy consumption to the neglect of the household level analysis.

From the foregoing, the study investigates how households are deprived of clean energy for domestic use. The nagging questions worthy of investigation include: What is the pattern and nature of energy deprivation by households in Ghana? Does energy deprivation depend of regional location? Are rural households more deprived than urban households? Does energy deprivation depend on wealth and other socioeconomic variables?

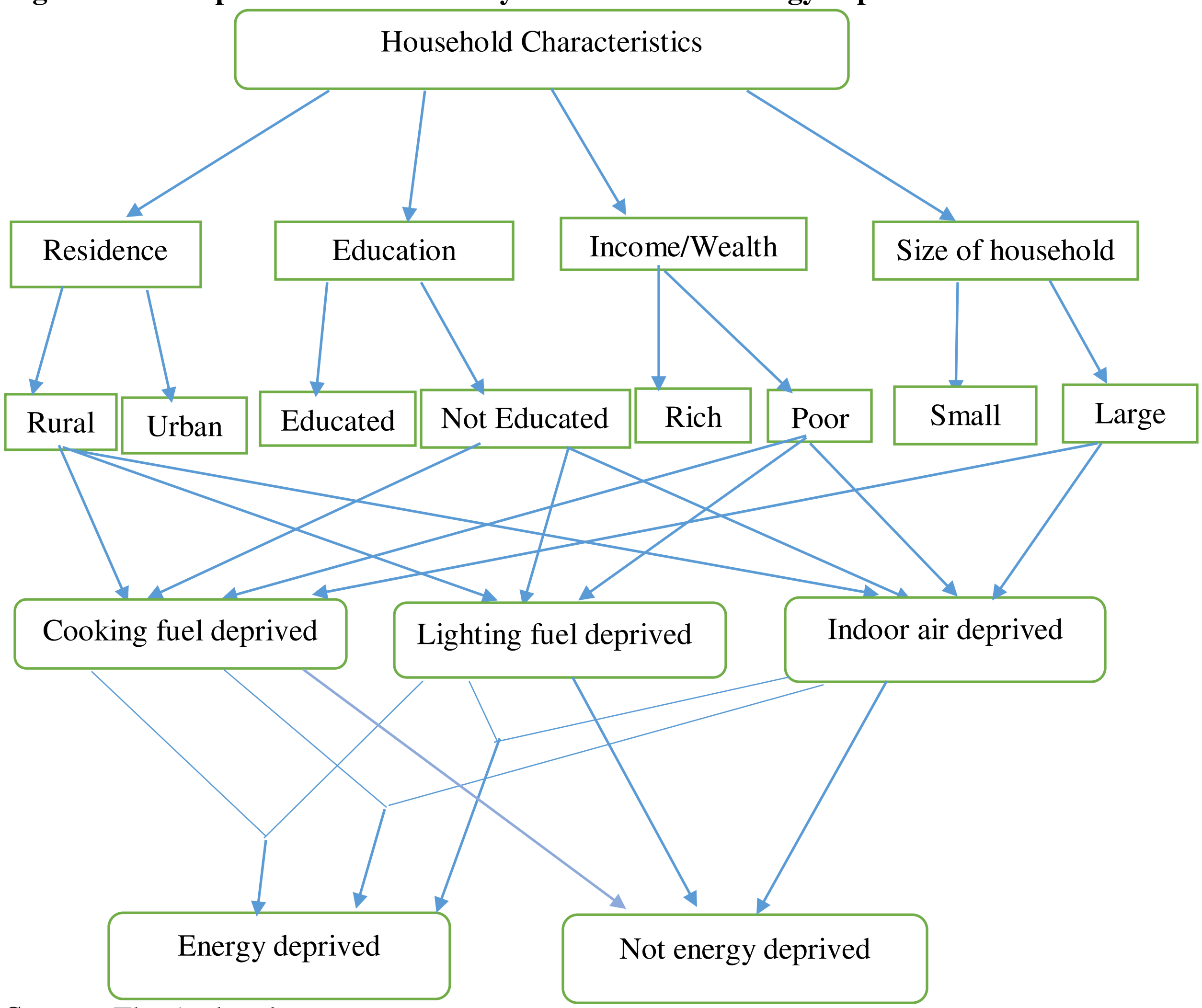
Answers to the underlying questions to the best of knowledge have not been provided in the sparse energy literature on Sub-Saharan Africa in general and Ghana in particular. Accordingly, while the attendant literature has focused on energy crisis and environmental mismanagement (Arabatzis & Malesios, 2013; Rafindadi, 2016), little is known about domestic energy consumption within the framework of deprivation versus likelihood of access. Some notable contemporary energy-oriented studies that have failed focus on energy deprivation include: Apkan and Akpan (2012), Afful-Koomson (2012), Akinyemi *et al.,* (2015, 2019), Jarrett (2017), Efobi *et al.,* (2019) and Asongu and Odhiambo (2019, 2020a).

In the light of the above, the positioning of this study, in view of providing answers to the underlying questions within the context of Ghana, contributes to the energy literature in view of providing policy makers with insights into how a country that is characterised by some of the world's worst energy grids systems can address concerns of energy deprivation that have unfavourable consequences to both human and economic developments (Rafindadi, 2016; Jarrett, 2017; Balsalobre-Lorente *et al.,* 2018; Asongu, 2018; Alola *et al*., 2019a, 2019b; Saint Akadiri *et al.,* 2019; Bekun & Agboola, 2019; Bekun *et al.,* 2019a, 2019b; Asongu & Odhiambo, 2020b, 2020c). This study contributes to knowledge in the area of household energy consumption. We assert that the nature of household access versus deprivation of energy for household use, dwell to some extend the socioeconomic characteristics of the household and the locational status. Our findings support the demand side theory of household energy consumption.

2. **Conceptual Framework**

From the literature covered in the previous section, it can be said that there are many socioeconomic factors that influence household adoption of fuel for domestic use. However, the major ones that determine household access or deprivation to these fuels are: the income/wealth of the household, educational level of the head of the household, residence (rural or urban) where the household is based and the size of the household. To this, the conceptual framework this study adopts expounds that these four variables (income/wealth, education, residence and size of the household) are taken as the major determinants of the deprivation versus likelihood of access of household fuel consumption for domestic use in Ghana. Figure 1 explains the conceptual framework.

Figure 1: Conceptual framework analysis of household energy deprivation



Source: The Authors'

In Figure 1, three kinds of energy deprivations are used; cooking fuel deprivation, lighting fuel deprivation and indoor air deprivation. A household is considered cooking fuel deprived if it uses fuels other than clean and modern ones (such as electricity and LPG) to cook.

In another way, a household is cooking energy deprived if it uses biomass such as wood, grass, animal dung, *inter alia*, as its main cooking fuel. If a household uses fuels other than main electricity or generator for lighting, then such household is considered lighting deprived. Also, a household that uses biomass fuels (grass, animal dug, wood, *inter alia*, that emit smoke to pollute the indoor air quality) and cooks inside its abode (i.e., there is no separate room as kitchen) in an open fire, then such household is indoor air deprived.

Four different socioeconomic variables that are deemed to affect the likelihood of adoption or deprivation of households' fuel usage are highlighted in Figure 1. If a household stays in a rural setting, such a household is more likely to be affected by all three kinds of deprivations (cooking, lighting and indoor air) as compared to its counterpart in an urban area. A well-educated person (household head) is likely to be employed and can afford clean fuels and hence, will not be deprived as compare to an educated person who may be less employed and unaware of the dangers of using dirty fuels. Poor households may not be able to afford and hence, have a high likelihood of being deprived in all three kinds of energy deprivations.

In the figure, if a household is deprived in any two or more of the deprivation indicators (cooking, lighting and indoor air), it is considered as being energy deprived and if a household is deprived in one of the indicators but not deprived in the others, such a household is considered as not energy deprived. For instance, a household that is deprived in only the lighting dimension is considered as not energy deprived. Such household may use LPG to cook and have a separate room as kitchen, but such a household is not connected to the electricity grid or use generator set. In this case such household is not energy deprived.

3. **Data and Methodology**

3.1 Data

Ghana Demographic and Health Survey data[2] (GDHS VI) for 2014 was used for the study. The data involved selecting sample points (clusters) consisting of enumeration areas (EAs). A total of 427 clusters were selected (216 urban and 211 rural). Then systematic sampling of households through a household listing operation in all of the selected EAs and households were randomly selected from these lists. A total sample size of 12,831 households was selected and

[2] It is a public data and available on the internet at www.DHSprogram.com with identification number GH_2014_DHS_09012016_734_98554.

11,835 households were successfully interviewed, yielding a response rate of 99 percent. Three questionnaires were used for the 2014 GDHS: The Household Questionnaire, the Female Questionnaire, and the Male Questionnaire. There were missing observations for certain variables so we adjusted our sample to 11,366 households, which capture full observations for all our variables of interest. Dummy variables were coded with 0 and 1. For the sex of household head (0=female, 1=male), for residence where household stays (0=rural, 1=urban), for wealth status (0=poorest, 1=poorer, 2=middle, 3=richer, 4=richest), for the educational level of household head (0=No formal education, 1=primary, 2=secondary, 3=higher) while the size of household and age of household head are continuous variables.

3.2 Methodology

Nussbaumer, Bazilian and Modi (2012) constructed the Multidimensional Energy Poverty Index (MEPI), which is an index of acute multi-dimensional poverty and reflects energy deprivation in very rudimentary services and core human functions. Using the deprivation method composed by Nussbaumer *et al.,* (2012) and drawing from the works of Karakara and Osabuohien (2020) and Karakara and Dasmani (2019), this study looked at the degree, determinants and pattern of energy deprivation in Ghanaian households. Three energy deprivation categories are used; cooking energy deprivation, lighting energy deprivation and indoor air pollution. In measuring cooking fuel deprivation: a household is deprived of modern cooking fuel if the main cooking fuel is not electricity, neither gas/oil nor kerosene. For lighting energy deprivation, a household is deprived, if its source of light is not main electricity/generator set. Indoor air pollution is where a household that uses biomass fuels (grass, animal dug, wood, *inter alia*, that emit smoke to pollute the indoor air quality) and cooks inside its abode (i.e. there is no separate room as kitchen) in an open fire, then such household is indoor air deprived. Thus, Nussbaumer *et al.,* (2012) energy poverty index is captured as;

$$Multidimensional\ Energy\ \ Poverty\ Index\ (MEPI) = A \times H \qquad (1)$$

Where H is the headcount ratio, which is the proportion of the households considered to be energy poor. The headcount ratio is the total number of households considered deprived over total households and ‘A’ is the intensity of multidimensional energy poverty (0—not intense, meaning access to basic energy services, 1—intense, no access to basic energy services).

Three different binary logit regressions are run based on the three different deprivations. Let *Pi* be the probability of a household deprived in cooking fuel, such that the probability of not being deprived will be *1-Pi*. Let us assume that a household being cooking fuel deprived depends on unobservable utility of adopting a certain fuel index by *Ii*, that is determined by the explanatory variables (household characteristics) in such a way that the larger the value of *Ii*, the greater the probability of the household being fuel deprived. *Ii* can be expressed as $I_i = b_1+b_2X_i$. Thus, this is captured as a conditional probabilities model as in equations (2) and (3).

$$Pi = \Pr(Yi = 1|X) = F(X_i^1\beta) \quad (2)$$

$$1 - Pi = \Pr(Yi = 0|X) = F(X_i^1\beta) \quad (3)$$

It is possible, however, to reformulate these equations in terms of the odds ratio of the probability of a household being energy deprived and the probability of not as follows:

$$\left[\frac{Pi}{1 - Pi}\right] = \frac{1 + e^{(\beta_0+\beta' Xi)}}{1 + e^{-(\beta_0+\beta' Xi)}} \quad (4)$$

$\left[\frac{Pi}{1-Pi}\right]$ is simply the odds ratio in favour of the household adopting clean fuels, thus, not being deprived, which is simplified as;

$$\left[\frac{Pi}{1 - Pi}\right] = e^{(\beta_0+\beta' Xi)} \quad (5)$$

where X_i represents household characteristics that influence the likelihood of being energy deprived.

The main household characteristics (variables in this study) are studied based on literature. Households with different socioeconomic status are likely to make differing choices regarding their energy use, thus, the household heterogeneity should be taken into account in models. In some studies, authors agreed that socio-economic factors may influence the choice of fuel type by a household (Karakara & Osabuohien, 2020; Akpalu *et al.,* 2011). Thus, the main variables used by this current study are: gender of household head, age of household head, household membership size, educational level of household head, residence (rural or urban) nature of household, wealth status of household and the regional location of household.

Household size, as one of our variables, which is usually measured by the number of occupants in the household, is uniformly found to be significant and positively signed in the studies analyzed. That is, the greater the number of occupants in a household, the greater the level of energy consumed or forms of energy. Braun (2010) found that household size is positively related to the presence of multiple heating modes in the home and Karakara and

Osabuohien (2020) indicated that larger households have a greater likelihood of consuming dirty fuels in Ghana as they may need to cook more food at home. Age is another variable that most studies include in analysing household demand for energy. Majority of the studies find a positive relationship between age of the head of household and energy consumption. This finding was especially prevalent in electricity demand studies that indicate that people will need to use more energy especially for heating purposes as they get older because they are at home more often and because they require a higher heating requirement. Also, the educational level of household head is captured as a categorical variable to show variation in the choice and use of various fuels (deprivation versus access) between levels of education as has been studied by some authors (Chambwera & Folmer, 2007). The inclusion of this variable is to observe how education affects the choice and use of fuels for domestic consumption in Ghana.

Again, most studies also include a location variable based on urban/rural or regional divide. Perhaps as expected, urban areas are found to consume relatively more electricity (Filippini & Pachauri, 2004) and gas (Bernard *et al.,* 1996) while living in rural areas increase a households' gasoline consumption (Manzan & Zerom, 2010). Rural areas are known to have abundant fuel wood, grasses, animal dung, agricultural crops, which are collected free of charge (no monetary cost); this is not the case in urban areas. We include this variable to capture differences emanating from rural–urban disparities. Income earning or wealth status also determines the likelihood of some fuels being consumed than others by households. The level of wealth/poverty could determine which fuel a household is likely to use. This variable is categorical and included to show how differences in wealth status could affect the likelihood of using different fuels by households in Ghana. Also, the gender of a household head is included to observe the effect of gender disparities between the household heads and how it affects the choice and use of fuels for cooking and lighting. The sex of household head cannot be left out, since most male headed households have economic potential than female headed ones. Household heads that are married can easily pool resources together to afford certain fuels, compared to unmarried household heads. Lastly, to control for variation in the use of fuels that may arise as a result of regional differences, a set of dummy variables are introduced to capture the regional effect. Ghana has ten administrative regions with each region having its own unique characteristics in terms of geographical endowment, composition of ethnic groups, and access to different fuels at different rates.

4. **Results and Discussion**

4.1 Regional Differences in Fuels for Cooking and Lighting

Regional[3] disparities in fuel access for cooking indicates that, Greater Accra, Ashanti and Eastern regions together accounted for 67.36%, while the other seven regions together accounted for 32.64% of the households using electricity for cooking. With regards to LPG/Natural gas usage, 69.49% of the households using it are from Greater Accra, Ashanti, Central and Western regions while the remaining 30.51% reside in the other six regions of Ghana. The three regions of the north (i.e. Northern, Upper East and Upper West regions) in total, account for 8.08% of the households using LPG for cooking. For households using kerosene as their main source of fuel for cooking, 76.19% are from Greater Accra, Western, Central and Upper East regions, while the rest of the other regions account for 23.81% of the households using kerosene to cook.

Five regions (namely, Western, Central, Greater Accra, Eastern and Ashanti) together, accounted for 64.57% of the total households using charcoal as their main fuel for cooking, while the other five regions accounted for 35.43%. Northern, Brong-Ahafo and Eastern regions together accounted for 41.87% of households using wood as their main source of cooking fuel, when the Upper East and Upper West regions are added to these; in total the five regions account for 63.09% of households using wood to cook. Meanwhile, the remaining five regions account for 36.91%. The Upper East region alone accounted for 85.83% of these households using other forms of fuels (grass, animal dung, crop residue, straws, *inter alia*), with no household from Greater Accra, Ashanti and Northern using such fuels. These three fuel types (i.e., LPG, charcoal and wood) cut across every region as the fuels used by majority of households except in the Upper East region where charcoal, wood and other forms of fuels (grass, animal dung, and crop residue) are what the majority (i.e. 90%) of households use.

[3] Ghana currently has 16 regions, as 6 more regions were created by referendum in February 2019.

Table 1: Fuel access for cooking in the various regions of Ghana

Regions	Electricity (%)	LPG/ N. Gas (%)	Kerosene (%)	Charcoal (%)	Wood (%)	Others* (%)	Total
Western	4(4.21)	327 (14.28)	3 (14.29)	411 (11.58)	496 (9.37)	2 (1.67)	1,243
Central	3(3.16)	255 (11.14)	2 (9.52)	447 (12.60)	481 (9.09)	4 (3.33)	1,192
Greater Accra	32(33.68)	645 (28.17)	6 (28.57)	529 (14.91)	62 (1.17)	0 (0.00)	1,274
Volta	0(0.00)	177 (7.73)	1(4.76)	343 (9.67)	563 (10.64)	3 (2.50)	1,087
Eastern	17(17.89)	186 (8.12)	1 (4.76)	430 (12.12)	644 (12.17)	1 (0.83)	1,279
Ashanti	15(15.79)	364 (15.90)	1 (4.76)	474 (13.36)	350 (6.61)	0 (0.00)	1,204
Brong Ahafo	9(9.47)	151 (6.59)	0 (0.00)	265 (7.47)	831 (15.70)	4 (3.33)	1,260
Northern	7(7.37)	35 (1.53)	1 (4.76)	193 (5.44)	741 (14.00)	0 (0.00)	977
Upper East	2(2.11)	92 (4.02)	5(23.81)	236 (6.65)	542 (10.24)	103 (85.83)	980
Upper West	6(6.32)	58 (2.53)	1(4.76)	220 (6.20)	582 (10.98)	3 (2.50)	870
Total	**95(100)**	**2,290 (100)**	**21 (100)**	**3,548 (100)**	**5,292 (100)**	**120 (100)**	**11,366**

Note: *Others include straw/shrubs/grass/agricultural crops/animal dung. Percentages are within brackets

Source: Authors' computation using GDHS data 2014

Regional disparity in fuel for lighting shown in Table 2, indicates that, five regions; Western, Central, Greater Accra, Ashanti and Eastern together accounted for 4,925 households out of 7,799, representing 63.15% of households using main electricity as fuel for lighting, while the other five regions account for 36.85%. For generator usage as source of lighting, 36.76% of households using it for lighting are from Greater Accra and Ashanti regions. Northern, Upper East and Upper West regions together account for 13.24% (40 out of 302 households) of households using generator for lighting, which is far less than the percentages for Greater Accra (22.52%) and Ashanti (14.2%) regions. This could be attributed to the cost of using a generator for lighting compared to the other forms of fuels. The three regions of the north are among the poorest regions while Greater Accra and Ashanti regions are among the richest in the country. These differences in regional wealth account for such disparity in the usage of energy types among the regions. In all the regions, electricity from national grid is the main source used by most households for lighting, followed by other forms and then generator. However, three regions (i.e. Northern, Upper East and Brong-Ahafo) account for 47.14% (1,539 out of 3,265 households) of the total households using other forms of fuel for lighting such as lanterns, flashlight, candles, and solar. The finding that electricity is the main source of fuel for lighting across the country can be attributed to the government's electrification programmes (Northern Electrification and System Reinforcement Project in 1985, National Electrification Project in 1990, Sustainable Energy for All Action Plan, *inter alia*) over the years. This has placed Ghana third after South Africa and Mauritius in terms of majority of citizens being connected to the national grid (Kemausuor *et al.,* 2011).

Table 2: Regional differences in fuels for lighting

Regions	Fuel types for lighting			Total
	Others*	**Electricity**	**Generator**	
Western	203 (6.22)	1,007 (12.91)	33 (10.93)	1,243 (10.94)
Central	218 (6.68)	938 (12.03)	36 (11.92)	1,192 (10.49)
Greater Accra	91 (2.79)	1,115 (14.30)	68 (22.52)	1,274 (11.21)
Volta	327 (10.02)	740 (9.49)	20 (6.62)	1,087 (9.56)
Eastern	353 (10.81)	894 (11.46)	32 (10.60)	1,279 (11.25)
Ashanti	190 (5.82)	971 (12.45)	43 (14.24)	1,204 (10.59)
Brong Ahafo	480 (14.70)	750 (9.62)	30 (9.93)	1,260 (11.09)
Northern	456 (13.97)	509 (6.53)	12 (3.97)	977 (8.60)
Upper East	603 (18.47)	357 (4.58)	20 (6.62)	980 (8.62)
Upper West	344 (10.54)	518 (6.64)	8 (2.65)	870 (7.65)
Total	**3,265**	**7,799**	**302**	**11,366**

Note: *Others include lanterns, candles, flashlight, solar. Percentages are provided in brackets
Source: Authors' Computation using GDHS data 2014

4.2 Urban/Rural differences in fuel for cooking and lighting

The study distinguished access to energy use by types on rural and urban bases because issues related to rural deprivation are fundamentally distinct from those of urban deprivation and the challenges related to providing access to energy for the rural poor differ from those in the urban areas. In Panel A of Table 3, among households using electricity to cook, 87.4% are from urban settings while 12.6% are from rural homes. With regards to LPG/Natural gas, 83.71% of households using LPG are from urban areas while 16.29% are from rural areas. Panel A of Table 3 reflects the fact that the percentages of urban households which use electricity, LPG/Natural gas and kerosene, are more than the percentages of rural households using the same types of energy. In the same vein, the percentages of rural households are more than the percentages of urban households in the use of wood and other forms of fuels (grass, animal dung, crop residue, and shrubs). However, with regards to charcoal usage, urban households use it more than rural households, partly because it is cheaper and reliable than most modern fuels in Ghana. Moreover, it is more efficient than wood and other non-modern fuels. This corroborates the conclusion that solid fuel usage is pervasive in Ghanaian households (Karakara, 2021).

Table 3: Rural/Urban differences

Panel A: Rural/Urban differences in access to energy for cooking

Types of cooking fuel	**Types of Residence**		
	Urban (%)	**Rural (%)**	**Total**
Electricity	83 (87.37)	12 (12.63)	95
LPG/Natural gas	1,917 (83.71)	373 (16.29)	2,290
Kerosene/Lignite	16 (76.19)	5 (23.81)	21
Charcoal	2,562 (72.21)	986 (27.79)	3,548
Wood	1,040 (19.65)	4,252 (80.35)	5,292
Others*	16 (13.33)	104 (86.67)	120
Total	**5,634 (49.57)**	**5,732 (50.43)**	**11,366 (100)**

Panel B: Urban/Rural differences in access to energy for lighting

Types of fuel for Lighting	**Types of Residence**		
	Urban (%)	**Rural (%)**	**Total**
Generator	177	125	302
	(58.61)	(41.39)	(100)
Electricity (Grid)	4,831	2,964	7,795
	(61.98)	(38.02)	(100)
Others*	623	2,642	3,265
	(19.08)	(80.92)	(100)
Total	**5,634**	**5,732**	**11,366**

Note and Sources: (i) For Panel A same as in Table 1 and (ii) For Panel B, same as in Table 2

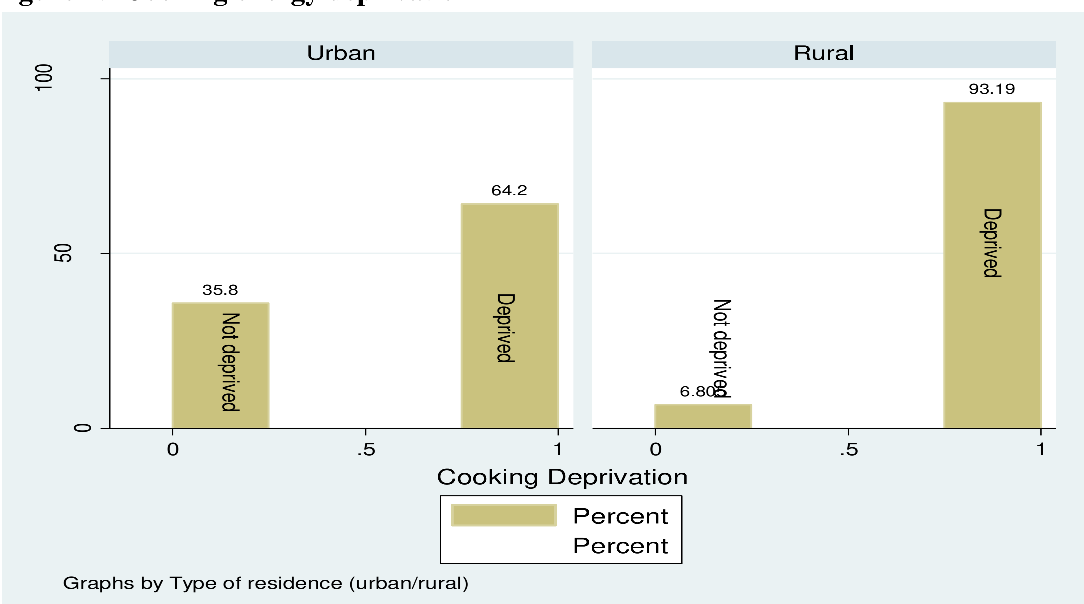
The Rural-Urban differentials in fuel type used for lighting are reported in Panel B of Table 3. The values show that 58.61% of the households using generator as the main source of lighting are from urban settings while 41.39% are from the rural areas. This is consistent with the findings of Awan *et al.,* (2014) that indicate that majority of those who use clean fuels in Pakistan are urban dwellers. With regards to electricity from the grid, 61.98% of households using it as a source of lighting are from urban homes, while 38.02% are from rural settings. Comparatively, more urban households use a generator as the main source of electricity than rural households. However, other forms of fuel for lighting such as lanterns, candles, solar, and flashlight are used more by rural households than urban households. This is partly because there are still a lot of rural homes that are not connected to the national grid. Also, most of the rural dwellers are poor and cannot afford a generator and its running cost and maintenance.

4.3 Energy Deprivation

4.3.1 Cooking, Lighting and Indoor air deprivations

Cooking energy deprivation is when a household uses energy for cooking which is not modern like; electricity, gas, kerosene. Energy deprivation for cooking shows that, in terms of rural-urban divide, more rural households are deprived (93.19%) as compared to urban households (64.2%). Among the urban households, 35.8% are not deprived and with the rural households, only 6.8% are not deprived with regards to cooking, as shown in Figure 2. This shows that energy deprivation is a matter of residence nature or energy access is a matter of residence nature. Those in urban settings have access more than those in rural areas. This is in line with Edoumiekumo *et al.,* (2014) and Karakara and Osabuohien (2020) who concluded that urban households are less deprived compared to their rural counterparts.

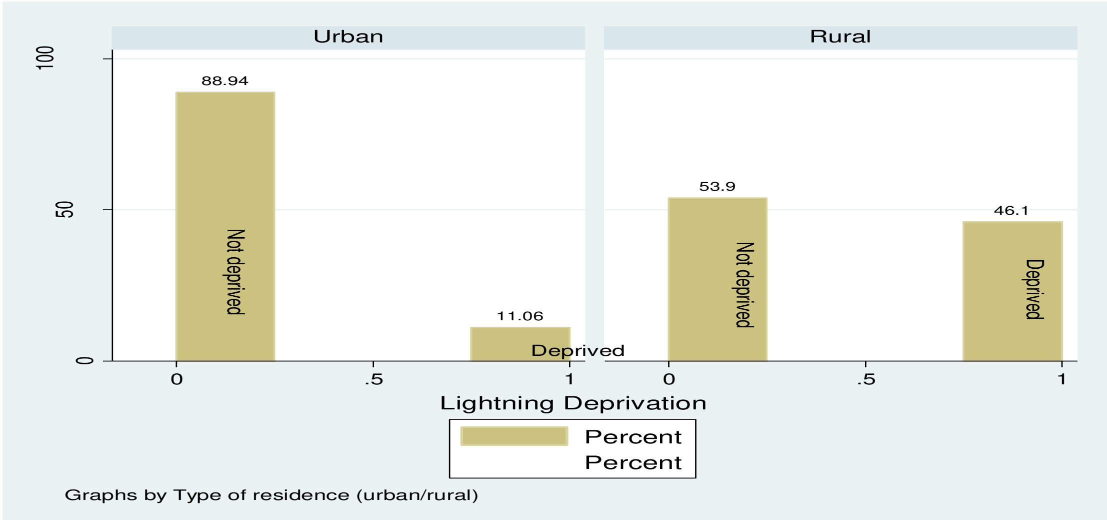
Figure 2: Cooking energy deprivation



Source: Authors' Computations using GDHS data 2014

A household is lighting deprived if the forms of fuel it uses for lighting are not linked to the main electricity (grid) or generator or modern forms. For energy deprivation in terms of lighting, out of the total urban households of 5631, 88.94% are not deprived in terms of access to clean fuels for lighting and for rural households (5731), 53.9% are not deprived. In Figure 3, comparing in percentage terms, rural households (46.1%) are more lighting deprived than urban households (11.06%), showing that energy deprivation is a matter of residence nature.

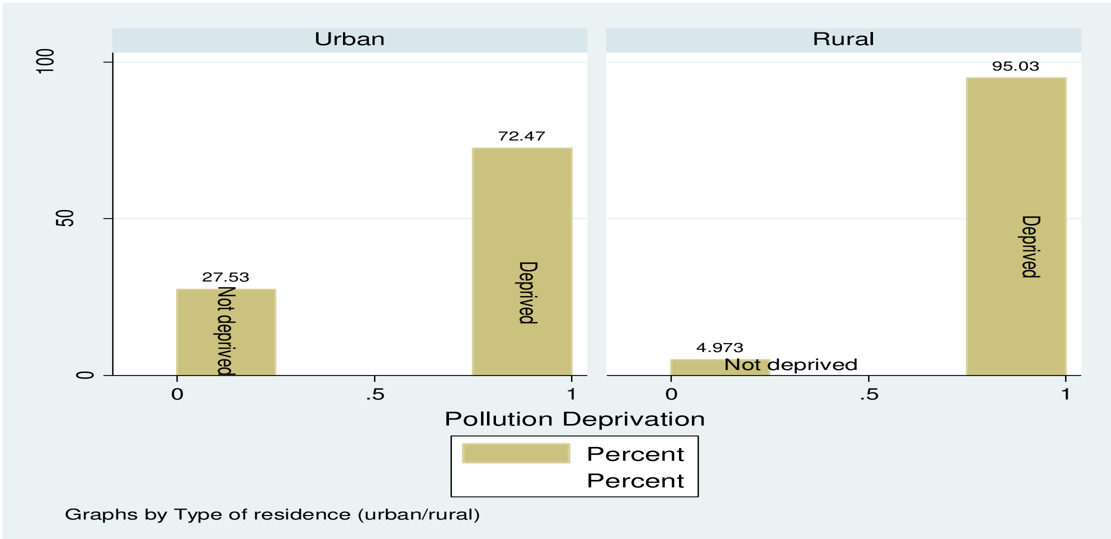
Figure 3: Lighting energy deprivation



Source: Authors'Computations using GDHS data 2014

Indoor pollution means that the place where the household cooks, and the forms of fuels used by a household pollute their indoor air quality, which can affect their good health (World Health Organisation – WHO, 2006). Figure 4 captures indoor air deprivation. Urban households (72.47%) are deprived as against 95.03% of rural households being deprived. Households not deprived and are urban constitute 27.53% of the total urban households and 4.973% of rural households are not deprived of indoor air quality. In conclusion, household energy deprivation is more in indoor air pollution followed by cooking deprivation, as for lighting, the deprivation is minimal. This is so partly because Ghana has made moves in access to electricity which placed it third after Mauritius and South Africa in terms of countries which have a higher proportion of its population having access to electricity in Sub Saharan Africa (Kemausuor *et al.,* 2011). Again, the country has energy policies (like the National Electrification Scheme, Northern Electrification Project and the Self Help Electrification Project, Sustainable Energy for All Action Plan, LPG Promotion Programme, *inter alia*) that have been implemented with some remarkable success and are responsible for such household energy success story.

Figure 4: Indoor air pollution



Source: Authors' Computation using GDHS data 2014

4.4 Econometric results

The econometric results are captured in Table 4. In the table, all the socioeconomic variables are deemed to determine household energy deprivation. A female headed household is 2% more likely to be deprived in cooking fuel access than a male headed household. As the age of the household head increases, the household's likelihood of being deprived in cooking fuel increases by 0.2% and deprivation in lighting fuel reduces by 0.1%. Similarly, as the size of household increases, it is accompanied by an increase in the likelihood of being cooking fuel deprived by 1.5% and lighting fuel deprived reduces by 1%. This means that as the number of household members increases, it is much costly to use electricity than charcoal to cook for such a large number. Hence, as the number of members of household increases, they adopt solid fuels (charcoal, wood, etc.). Also, as the number of household members increases, it is prudent to adopt electricity as fuel for lighting than other forms of fuels. This finding went this way possible because of the evidence (Karakara & Osabuohien, 2020) that in Ghana, certain fuel types are good for cooking certain staple food when cooked for large household members. Again, the country's electrification effort has led to many households being connected to the national grid and thus, access to clean energy for lighting becomes cheap while clean energy for cooking (like LPG) is not easily accessible to many homes.

Table 4: MER from logit regression of energy deprivation with socioeconomic variables

Explanatory Variables	Cooking energy deprivation	Lighting energy deprivation	Indoor air deprivation
Sex of Household Head	0.02***	0.010	0.003
(Female)	(0.01)	(0.01)	(0.01)
Age of Household Head	0.002***	-0.001***	0.0004**
	(0.00)	(0.00)	(0.00)
Size of Household	0.015***	-0.01***	0.010***
	(0.00)	(0.00)	(0.00)
Residence (Rural)	-0.046***	0.001	-0.055***
	(0.01)	(0.01)	(0.01)
Education of household head			
No formal education	Base category		
Primary	-0.0122	-0.018*	-0.029**
	(0.01)	(0.01)	(0.03)
Secondary	-0.051***	-0.049***	-0.059***
	(0.01)	(0.01)	(0.01)
Tertiary	-0.143***	-0.079	-0.131***
	(0.014)	(0.02)	(0.014)
Wealth Status of Household			
Poorest	Base category		
Poorer	-0.01**	-0.384***	-0.002
	(0.00)	(0.01)	(0.004)
Middle	-0.073***	-0.686***	-0.058***
	(0.01)	(0.013)	(0.01)
Richer	-0.29***	-0.793***	-0.231***
	(0.02)	(0.013)	(0.02)
Richest	-0.72***	-0.809***	-0.644***
	(0.02)	(0.013)	(0.03)
Regional location			
Western	Base category		
Central	0.011	0.002	0.014
	(0.01)	(0.01)	(0.01)
Greater Accra	-0.021**	0.057***	-0.022**
	(0.01)	(0.02)	(0.01)
Volta	-0.03**	0.006	-0.005
	(0.011)	(0.014)	(0.01)
Eastern	0.037***	0.035***	0.019*
	(0.01)	(0.013)	(0.01)
Ashanti	0.018*	0.031**	0.040***
	(0.01)	(0.02)	(0.01)
Brong-Ahafo	0.017	0.049***	0.002
	(0.011)	(0.013)	(0.01)
Northern	0.081***	-0.061***	0.084***
	(0.02)	(0.01)	(0.02)
Upper East	-0.065***	0.013	-0.028*
	(0.02)	(0.02)	(0.02)
Upper West	0.050***	-0.084***	0.079***
	(0.014)	(0.01)	(0.02)
Pseudo R^2	0.5230	0.4185	04449
Prob>Chi^2	0.0000	0.0000	0.0000
Log Likelihood	-2798.2393	-3963.5787	-2789.218
Observations	11,366	11,366	11,366

Note: standard errors are within brackets; ***; ** and * denote significance at 1%, 5%, 10%, respectively
Source: Authors' Estimation

Education is found to determine energy access and deprivation. As one is educated, the probability of being energy deprived reduces. In Table 4, having a secondary education leads to a reduction of 5.1% in the probability of being cooking fuel deprived as compared to one without formal education. As education improves from secondary to tertiary, the probabilities further reduce to 14.3%. A similar pattern is observed in lighting deprivation (from -4.9% to -7.9%) and indoor air pollution (from -5.9% to -13.1%). This finding is in line with Demurga and Fournier (2007) who indicated that as the head of the household is educated, it reduces the probability of using dirty fuel.

Table 4 further shows that wealth status is a full determinant of energy deprivation. Compared to a poor household, a rich household is 29% less likely to be cooking fuel deprived and 79.3% less likely to be lighting fuel deprived. Regional disparities also show that, compared to a household in the Western region, households in Greater Accra, Volta and Upper East regions have reductions in the probabilities of 2.1%, 3% and 6.5%, respectively, of being energy deprived in the cooking dimension. Households in Upper West are 5% more likely to be energy deprived in the cooking dimension and 8.4% less likely to be energy deprived in the lighting dimension compared to households from the Western region.

The strength of this paper lies in its effort to look at the likelihood of household energy deprivation versus access, of which other studies overlooked, notably, other studies dwell much on determinants of household energy consumption. Thus, policy practice could learn that household energy consumption is not necessarily a look at the determinants but also on deprivations as well as access likelihood. Moreover, the paper's strength is seen in its use of a large representative household survey data compared to other studies (Kwakwa & Wiafe, 2013; Demurga & Fournier, 2007; Kimemia & Annegarn, 2011) that have used a case study of districts and municipality.

However, this study is limited to Ghana as a study and the findings may not be applicable to other countries, especially developed countries. Also, the data for the study captured information on only households' main cooking fuel, thus we are unable to determine whether household fuel consumption depicts the fuel stacking hypothesis, where households use multiple fuels; however, this was not the interest of this paper. But evidence of fuel switching is apparent given that as a household's wealth index increases (from being poor to rich) it uses clean fuels.

5. Conclusion and future research direction

Energy access and deprivation in Ghana show some regional disparities, even though three fuel types (i.e., LPG, charcoal and wood) cut across every region as the fuels used by majority of households except in the Upper East region where charcoal, wood and other forms of fuel (grass, animal dung, and crop residue) are what majority (i.e. 90%) of households use for cooking. In all the regions, electricity from the national grid is the main source used by most households for lighting, followed by other forms of energy and then the generator. Also, energy access and deprivation showed some rural urban division. Those in urban settings have access to more than those in rural areas. This shows that energy deprivation is a matter of residence nature or energy access is a matter of residence nature. The education level of household head and wealth status of the household are found to fully determine energy access and deprivation. Increases in wealth leads to a reduction in the likelihood of being energy deprived. The reduction is more pronounced in cooking fuel deprivation followed by pollution and lighting fuel deprivation. As a household moves from a richer status to a status of households among the richest, it leads to a reduction in the likelihood of experiencing pollution indoors (-23.1% to -64.4%), cooking energy deprivation (-29% to -72%) and lighting energy deprivation (-79.3% to -80.9%). Hence, lighting fuel deprivation is minimal compared to cooking fuel deprivation and indoor air pollution.

Lack of access to modern energy by households, to some extent, is both a cause and a consequence of underdevelopment, which exacerbates poverty in general. This study emphasizes that household deprivation versus access of clean fuels should be a policy priority in view of making clean and sustainable energy for all. We indicated in this study that socioeconomic characteristics of households as well as their wealth standing greatly affect their likelihood of accessing clean energy. Our findings underpin the issue of demand side effect of household energy consumption as against the supply side studies. This is important given the nature of households in developing countries like Ghana. Households in such countries are mostly large in size (rural homes in particular) and engulfed with poverty issues as well as energy constraint countrywide. Thus, a study on the likelihood of access and deprivation of energy by households could offer in-depth policy formulation.

Efforts should be geared towards policies that will ensure households having access to clean energy fuels in order to reduce the deprivations and by extension, mitigate the effects of using dangerous or dirty fuels. These efforts in the light of Asongu *et al.* (2019) should be tailored to incorporate two main aspects, namely: environmental effectiveness and economic efficiency. First, from the perspective of economic efficiency, considering policy measures that are least costly will provide more possibilities of where and how to deliver clean energy while keeping investment costs low. Second, with respect to environmental effectiveness, measures should not be exclusively designed to increase clean energy consumption in the country, but should also be tailored to align with sustainable goals related to SDG 7, notably, that the energy should be reliable, modern, affordable and sustainable. These recommendations are particularly relevant in the light of the documented energy crisis in Africa as well as human and economic development shortfalls associated with lack of energy (Kifle, 2008; IRENA, 2010; Shurig, 2015; Akinyemi *etal.,* 2015; Akpan *et al.,*2015; Huxster *et al.,* 2015; Mbah & Nzeadibe, 2016).

Future research should look at the costs (i.e. monetary and opportunity costs of acquiring energy) related to energy access, since this could affect the decision of a household not to adopt clean fuel and such a household will be considered as deprived in this study. Moreover, further studies should also consider the relevance of information technology in improving conditions for the availability of clean energy in Ghana, in particular, and Africa, in general.

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