Energy conservation and efficiency awareness and practices of households in the Cape Coast Metropolis, Ghana

Abigail N.A. Baidoo,[1] Jones A. Danquah,[1] Edward K. Nunoo,[2]* Simon Mariwah,[1,2] Georgina Boampong[2]

Abstract

This paper assessed energy conservation and efficiency awareness practices of households in the Cape Coast Metropolis. It examined the level and variability in energy conservation practices, and the level of energy-savings awareness education among households. The findings reveal that years spent in school by household heads, income levels, expenditure, age of households and the number of times electricity power triples off daily were among key factors influencing individual's choice of energy-efficient appliances. There was significant variability between existing social strata in terms of income and use of electrical appliances among households. Based on the findings, this study recommends a robust energy literacy program to improve households energy efficiency practices awareness, and in order to ensure energy cost savings, environmental protection and climate change mitigation that will enhance the drive towards achieving the Sustainable Development Goal Seven (SDG 7).

Keywords

Energy conservation, energy efficiency practices, household electrical appliances, energy literacy, Cape Coast Metropolis, SDG 7

---

[1]Department of Geography and Regional Planning, University of Cape Coast, Ghana

[2]Institute for Oil and Gas Studies, University of Cape Coast, Ghana

***Corresponding author**: Edward K. Nunoo University of Cape Coast (UCC). Institute for Oil and Gas Studies. P.O. Box UC 148, Cape Coast-Ghana, Email: edward.nunoo@ucc.edu.gh ORCID: 0000-0001-6470-9770

Introduction

Energy conservation is about efforts seeking to reduce the amount of energy used for optimal domestic, corporate and industrial purposes. Synonymous with conservation goals, energy efficiency is situated in a context that judiciously appropriates energy through improved energy management systems, consumer behavioural change and or adoption of novel technology for use of energy resources and electrical appliances.[1] Electrical energy is applicable in all facets of human life and deemed essential for socioeconomic development. Inferring from Commerford,[2] the world's population, postulated to increase by 45% in the next 90 years, is expected to be equally met with energy demand that must not only be readily available, accessible and cheaper, but also cleaner to satisfy the zero net carbon demands. The universal call to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030 is what the 17 Sustainable Development Goals (SDGs) connotes. Adopted by 193 United Nations Organisation's (UNO) member States in Paris, including Ghana, the SDGs came into effect in January 2016. Also known as Agenda 2030, the SDGs aim to foster economic growth, ensure social inclusion, and protect the environment with five overarching themes; people, planet, prosperity, peace, and partnerships. SDG 7 is specifically dedicated to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030. Achieving goal 7 of the SDGs requires an overall robust energy sector development; transitioning from use of fossil fuels to renewables, non-conventional clean sources (Nuclear, Hydrogen), carbon sequestration and building resilient energy infrastructure.[1]

Global energy demand is on the increase.[3] It is projected to grow by 66% in 2050 from 2020 figures.[4] Rise in energy consumption rates has been dramatic as a result of increasing population growth rates, especially in emerging economies, and in response to the quest for sustainable economic growth.[4] Schwartz et al[5] and Shaari et al[6] adduce evidence that demonstrate a significant relationship between energy consumption and economic progress. Consequently, these fast-paced developments have generated significant environmental and economic concerns particularly in developing countries.[2] The tie plays out perfectly well in the annual population growth rates and electricity supply and demand trajectories in Ghana over the decade (Table 1). The interplay depicts steadily annual increase in population growth rates with a corresponding rise in electricity consumption to which corresponding growth in socio-economic development is expected. Marginal rates of electricity supply in Table 1, after 2015 generally looks appreciable in response to increases in energy demand over the period.

Table 1: Annual population growth and electricity demand in Ghana (2009-2019)

Year	Population (millions)	Electricity Supply(Mw)	Marginal rate of supply (Mw)	Electricity Demand (Mw)	Marginal rate of Increase (Mw)
2009	24,170,940	1423	-	1263	-
2010	24,779,619	1506	83	1391	128
2011	25,387,712	1665	59	1520	129
2012	25,996,450	1729	64	1658	138
2013	26,607,645	1943	214	1791	133
2014	27,224,473	1970	27	1853	62
2015	27,849,205	1933	-37	1757	-96
2016	28,481,945	2078	145	1997	240
2017	29,121,465	2192	114	2077	80
2018	29,767,102	2525	333	2371	294
2019	30,417,856	2804	279	2613	242
2020	31,072, 940	3090	286	2857	244

Source: Computed from Energy Commission Ghana data[7] and GSS[8]

Marginal rate of energy demand over the decade has increased faster than supply (Table 1) until after 2015 when unconventional energy sources were mainstreamed.[1,9] This period, which is sometimes referred to as 'Dumsor' (unannounced on-off electricity power supply), led to persistent deficits in primary energy supply. Increasing demand was largely attributed to rise in household energy consumption for various domestic services,[10] including charging of mobile phones. Per the SDG 7, this interplay (An economy with high-energy poverty, high-energy consumption, not readily available clean energy sources and resilient energy infrastructure) need to be balanced.

In-depth literature on energy conservation and efficiency in Ghana exist.[11,12,1] They adduce to the fact that various measures have been initiated to create awareness and to educate people on energy conservation and how to utilize energy judiciously.[13,14,15] However, very few studies have assessed households' roles in energy conservation and efficiency dynamics in the Cape Coast metropolis. The main goal of this study was to analyse energy conservation and efficiency practices, and present assessment's results on households' energy consumption on electrical appliances in the Cape Coast metropolis. Guided by three hypothetical questions underpinning objectives of the study, the paper specifically assessed the level of energy conservation awareness among households, examined efficiency practices and analysed socio-demographic factors influencing households' choice and use of electrical appliances in the Cape Coast Metropolis. In line with the objectives set for this study, the following hypothesis was developed;

i. H_0: There is no statistically significant difference in energy conservation practice among households in the Cape Coast metropolis.

   H_1: Statistically, there is a significant difference in energy conservation practice among households in the Cape Coast metropolis.

ii. H_0: There is no statistically significant relationship between income level and energy-saving practices among households in the Cape Coast metropolis.
H_1: There is a statistically significant relationship between income level and energy-saving practices among households in the Cape Coast metropolis.
iii. H_0: There is no statistically significant relationship between socio-demographic factors and choice of energy-efficient appliances among households in the Cape Coast metropolis.
H_1: There is a statistically significant relationship between socio-demographic factors and choice of energy-efficient appliances among households in the Cape Coast metropolis.

The significance of this study lies in its potential to inform energy efficiency policy and strategies for advancing sustainable economic development in the Cape Coast metropolis by creating awareness to conserve energy and adhering to best practices that will achieve the sustainable development goal seven (SDG 7) by 2030. Beyond contributing to literature, the findings of this study would also deepen understanding in awareness creation on energy efficiency practices among households.

Literature Review

Historical perspectives on energy conservation and efficiency

In direct response to the global oil price increases of the 1970s and the 1980s, high energy intensive consuming countries became concerned and saw a need to cut down on energy consumption.[16,17,18] Some countries reviewed their existing energy policies and incorporated energy conservation and later, energy efficiency practices as key aspects of their national energy policies.[16] This was in response to increase in judicious utilization of energy resources across the divide. In 1973, the San Diego California community in the United States of America initiated an energy efficiency program that integrated employee awareness campaigns to conserve energy through de-lamping, thermostat setbacks and revised operating procedures on the built environment energy systems.[19,20] It resulted in a 37% energy savings or 7 million kilowatt hours per year.[19,21] Subsequently, emergency energy conservation initiatives were introduced by many other national governments. Policies were adopted, formulated and initiated to promote rational use of energy. Energy conservation centers were established as parastatal budget Organisations to implement National Energy conservation programs such as those in South Korea the Korean energy management corporation-KEMCO in South-Korea and the Energy conservation centre-ECCJ in Japan.[22,23] In Australia and New Zealand emphasis on energy conservation measures were on projects aimed at reducing energy import requirements. Achieving a global perspective,[22] this led to enactment of an Energy Conservation Promotion act (ECPA) in Thailand (1992) and the Philippines' Department of Energy Act (PDoEA) in the same year. In 1995, the Iran Energy Efficiency Organization (SABA) was established as a budgetary parastatal while a Federal Law on Energy Savings (FLoES) was adopted by the Russian Federation in 1996. In Uzbekistan, the legislature passed a national law on rational use of energy (RUE) in 1997 whilst several other countries adopted energy audits practices which became mandatory for large scale industrial energy consumers.[24,6,25,26] Benefits associated with these conservation initiatives were recorded in terms of both energy and financial savings making energy efficiency measures an important component of industrial practices in both the developed and strongly emerging economies across the globe.[1] In recent years however, there has been a gradual paradigm shift from the earlier "*energy conservation*" policy goals and concepts, to "*energy efficiency*" policies and goals. Efficient electrical appliances' uses of energy will not only save households' income spent on energy but is also seen as an indispensable tool in the fight against climate change. The increasing role of active energy efficiency promotion towards achieving SDG) 7 and the zero net carbon dioxide (CO_2) emissions has become the new norm as embraced by the United Nations Organisation's (UNO) Member States.

Energy conservation and efficiency practices in Ghana

Energy conservation and efficiency management activities in Ghana range from relatively inexpensive and easily implementable actions which are referred to as “low hanging fruits” management.[1] These include turning off lights and switches when not in use and adhering to use of energy efficient appliances, to expensive technology such as using electric sub-meters to monitor and improve consumption use of alternative energy sources[27] and use of artificial intelligence.[9] According to Capehart et al,[22] it is advisable to work on these easier actions (“low hanging fruits”) and use benefits accruing to continue with higher levels until policy targets are attained, gains sustained and or improved upon. The Ministry of Energy and related allied agencies, since 2005, have rolled out and implemented key policies to manage inefficient distribution and use of energy. These include incentive-based policies to mandatory measures to regulate demand for energy products in the country.[28] The Ghana energy and efficiency policy in 2005 was part of a broader national energy policy that addressed all issues in the energy sector of the economy. The goal was to ensure efficient energy production, transportation, and use of energy in Ghana[15] by establishing appropriate pricing regime to induce domestic and industrial consumers to voluntarily manage their energy and also to support the education and awareness creation on the methods and importance of energy conservation.[1]

A regulation, triggered by legislative instrument (LI) 1815 in 2005 (Energy Efficiency Standards and Labelling Regulation) mandated manufacturers, importers and retailers of home electrical appliances to label all such gargets sold on the Ghanaian markets to indicate their efficiency levels and ensure that the appliances meet efficiency standards of the regulation.[1,10] This was followed by the efficiency lighting project in 2007 to replace all incandescent lamps with Compact Fluorescent lamps. About 6 million energy saving bulbs were distributed, saving Ghana 124 megawatts of electricity ($300million) in just three years after its implementation.[29] A year after (2008), the energy efficiency regulation (LI) 1932, was in force to prohibit the importation and use of second-hand home electrical appliances including television sets, refrigerators, fans, pressing iron, heaters and freezers[30,31] which had become absolute in terms of energy consumption. By way of intervention, the policy discounted and promoted the use of new and energy efficient home electrical appliances such as refrigerators and freezers to bait persons in possession of second-hand electrical appliances trade them for new efficient ones. About 400GWh of electricity and 1.1MT carbon emissions were saved through the refrigerator rebate and turn-in scheme.[32,30] In spite of all these interventions, large sections of the Ghanaian population, including the Cape Coast municipality, are still indifferent to energy conservation and efficiency practices.[33,15]

Energy conservation in the Cape Coast Metropolis

Inferring from the nationwide energy use survey data, initially published in 2012 and subsequently reviewed annually (Energy Commission, Ghana 2021), the average annual electricity consumption by key home electrical appliances sampled per households (kWh) in the metropolis depicts a snapshot (Table 2) of the situation on ground with a consumption rate of 1.5%. Electricity demand in the metropolis for residential and non-residential as at September 2019 stood at 4,829,916.05 kWh and 1,019,158.59 kWh respectively.[7] In a quest to intensify energy-saving practices among households, energy institutions embarked on energy-saving campaigns in Cape Coast to educate households on conservation and efficiency practices. Electricity demand in the metropolis for residential and non-residential as at September 2019 stood at 4,829,916.05 kWh and 1,019,158.59 kWh respectively.[7] In a quest to intensify energy-saving practices among households, energy institutions embarked on energy-saving campaigns in Cape Coast to educate households on conservation and efficiency practices. This resulted in use of energy-efficient bulbs that requires less energy to produce same levels of energy services.[31]

Table 2: Annual average electricity consumption of electrical appliances (KWh/household)

Region	Electrical Appliances					
Central	Refrigerators	Lighting	Television	Fan	Iron	Other
	876.6	233.0	116.9	112.3	51.1	43.8

Source: ECG, 2016.

Financial constraints, however, have been cited as a key reason why households will opt for inefficient electrical appliances.[34] Kwakwa and Adu[11] (2016) identified other factors that include demographical features, information and concern for the environment, dwelling characteristics, subjective norms and perceived benefits as also paramount in conserving electrical energy among households. Energy users are more likely to reduce their consumption when they develop strong personal norms as they will morally be obliged to perform such practice.[35]

Energy conservation awareness and information dissemination

Many researchers have highlighted the role of consumer awareness in electrical energy conservation.[1,11] It is reported that the excessive electricity consumption may be attributed to wasteful practice by users.[11] Consumers exhibit these wasteful practices due to inadequate knowledge in or awareness on use of energy efficiently and its related implications.[36] For Ouyang and Hokao,[37] people tend to be unconcerned about energy efficiency problems because of their ignorance of the relation between daily energy use that has resulted in its socio-economic problems faced by households and the global environmental impact in the world today. Affected directly by human attitudes and cultural tendencies[38], energy conservation and efficiency awareness campaigns will enable households relate energy use to their socio-economic problems and the continuing warming of global surface temperatures.[39,40,11] The best way to be electrical energy efficient is to be aware of how energy is used.[41] Increasing electricity conservation awareness eliminates consumer apathy towards judicious use of electricity.[10] It has a high probability of inducing households to adopt energy-saving practices.[42] Thus, massification of awareness and the ability to control usage is an effective means to implement energy efficiency policies.[37,14] Energy efficiency campaigns and awareness creation is, therefore, an effective tool that can help ensure energy conservation among consumers.[42,8] (Agyarko, 2016; ECG, 2021).

Context and Methodology

Case study area

The Cape Coast Metropolitan in the Central Region is one of the 22 Metropolitan, Municipal and District Assemblies (MMDAs) of Ghana. The municipality lies within latitudes 5^0.07' to 5^0.20' north of the Equator and between longitudes 1˚.11' to 1˚.41' west of the Greenwich Meridian with a total land area of approximately 122 sq. km (12,200 ha). It is bounded on the East by Abura-Asebu-Kwamankese District (A.A.K), to the by West by Komenda-Edina-Eguafo-Abrem (K. E. E. A.) District, to the North by Twifo-Heman Lower Denkyria District (T.H.L.D) and to the South by the Gulf of Guinea (Figure 1). The choice of Cape Coast municipality as the case study is informed by two important factors. First, the metropolis serves as the Central Region's administrative capital with a number of very good second cycle schools and tertiary institutions (University of Cape Coast and Cape Coast Technical University) in Ghana. Economic activities include fishing, trade and Government administration. Second, the municipality is well noted for its ecotourism endowment and cultural-heritage tourists' attractions that can be traced down to the era of Ghana's early encounter with European trade in gold, ivory, and later the infamous slave trade. The university of Cape Coast, with its expanding satellite communities, is the largest consumer of electricity in the metropolis. The target population for this study is households in the metropolis. Primary electrical energy users (household heads) were selected from each household as respondents to the study.

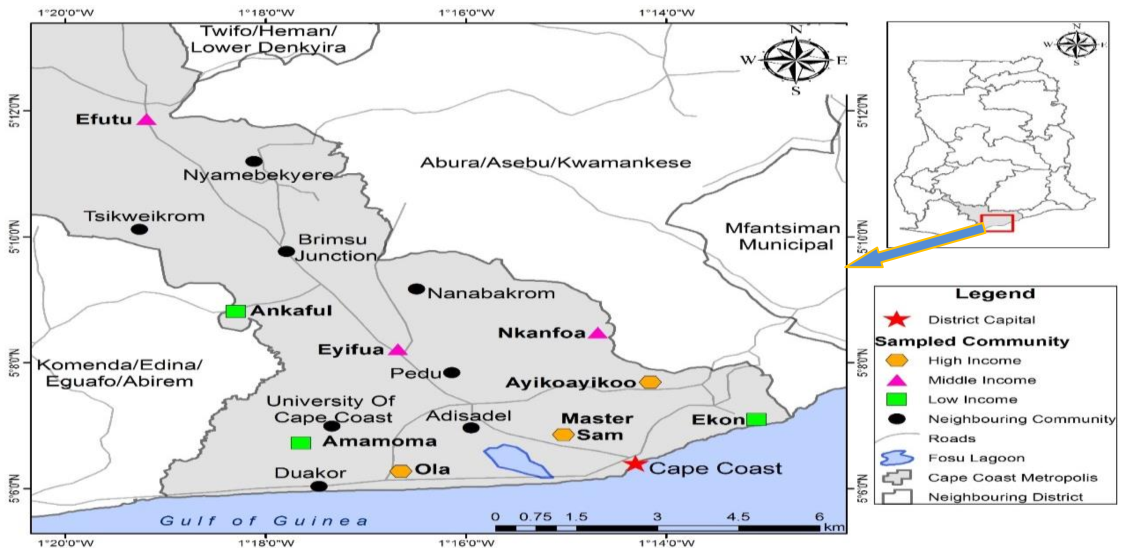

Figure 1: Study Area Map of Cape Coast Metropolis,
Source: Authors construct, 2021

Sampling procedure and research instruments

The research was carried out over a three month period (July-September) in 2021. Out of the total population of 40,386 households in the Cape Coast metropolis,[8] a sample size of 396 households were selected to participate in the quantitative field data for this study.[43,44] The total population of 40,386 households[8], was divided into 3 strata (high income, middle income and low-income communities). A sample size of 396 households was selected based on Glenn.[44] Three communities were selected from each stratum (9) using the lottery version of the simple random sampling procedure. After the communities were identified, the total sample size (n=396) was divided among the 9 communities and 44 households were identified as respondents from each selected community using the convenience sampling method. Questionnaires and interview guides were employed to collect qualitative data after obtaining ethical cleared from the University of Cape Coast (UCC). Five in-dept interviews were purposively conducted with identified stakeholders from the Electricity Company of Ghana, assembly members who are also community leaders and representatives of their various communities in the Local Government. The Kobo collect Application (KCA) was used to collect the quantitative field data. Pre-testing was done by screening the research instruments with faculty members and other staff within the Geography and Regional Planning Department at the University of Cape Coast after which the instruments were revised. During the pilot test, questionnaires were administered to 20 respondents through the convenience sampling technique at the Kwaprow village in the Cape Coast metropolis (Figure 1).

Analytical and conceptual framework

Households' decision to choice energy-efficient appliances is influence by socioeconomic conditions or environment in which they operate.[45] Thus, household's (or individual) decision to use energy-efficient appliances is based on the satisfaction derive from use of such an electrical appliance. Modelled on the utility maximization framework, utility of using energy-efficient appliance is denote by U_{1i} and decision not to use energy-efficient appliance by U_{0i}. According to Asinyaka[45] however, U_{1i} and U_{0i} are latent variables expressed as follows:

$$U_{1i} = X_i \beta_1 + \varepsilon_{1i} \quad (1)$$

$$U_{0i} = X_i \beta_0 + \varepsilon_{0i} \quad (2)$$

Where X_i is the vector of individual or household characteristics, and epsilon ε (s): ε_{1i} and ε_{0i} are random errors terms, hence household or individual i who uses energy-efficient appliance is given as:

$$U_{1i} > U_{0i} \rightarrow \varepsilon_{0i} - \varepsilon_{1i} < X_i(\beta_1 - \beta_0) \quad (3)$$

Individual i utilizes energy–efficient appliances when $U_{1i} > U_{0i}$, then y_i is equal to 1, otherwise y_i = 0. Hence, the probability that y_i = 1 is given as $\Pr[\varepsilon_{0i} - \varepsilon_{1i} < X_i^{'}(\beta_1 - \beta_0)]$. This probability has dichotomous outcome. However, in this particular instance y was parameterized using an index that takes on values 0, 1, 2,……….n. The special nature of the dependent variable y means that it cannot be estimated using ordinary least squares. This is best estimated using Poisson regression model. The probability function of Poisson distribution for the number of occurrences of the event is given as:

$$f(y_i \mid X_i) = \frac{e^{-u_i} \mu_i^{y_i}}{y_i!}, \quad y_i = 0,1,2,\ldots\ldots\ldots, \quad (4)$$

Where y_i is count the discrete number of event or random variable, and the mean parameter and the variance equal to u_i. This is one parameter distribution.[46] To add exogenous variables of $X_{ij}(j = 1\ldots\ldots\ldots, K)$, as well as a constant, the parameter u_i is specified to be:

$$\mu_i = \exp(X_i^{''} \beta) \quad (5)$$

Consequently, $E[y_i] = u_i = e(X_i \beta)$ and $V[y_i] = u_i = e(X_i \beta)$ (6)

Given equations (4) and (5) based on the assumptions that the observation $(y_i \mid X_i)$ are independent the usual estimator is maximum likelihood (ML).[46] The log-likelihood function is

$$\ln L(\beta) = \sum_{i=1}^{n} \left\langle y_i X^{'} \beta - \exp(X_i^{'} \beta) - \ln y_i! \right\rangle \quad (7)$$

The maximum likelihood estimator for Poisson is represented as $\hat{\beta}_p$ for the solution to K non-linear equations, the first order maximum likelihood condition is given as:

$$\sum_{i=1}^{n} (y_i - \exp(X_i^{'} \beta)) x_i = 0 \quad (8)$$

Equation (8) can be solved using Newton-Raphson algorithm to obtain the parameters estimates. Based on Cameron and Trivedi[47] and Danquah et al[13], the empirical model of the Poisson regression model in this study is specified as:

$$y_i = e^{X.\beta} + \varepsilon_i = e^{(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots + \beta_k X_k)} + \varepsilon_i \quad (9)$$

Where y_i refers to an index for using energy conservation appliance and X_i (s) are explanatory variables represent all social demographic factors that influence households' decision to choice energy–efficient appliances or energy conservation behaviour of households. The ε_i sign is an error term and $\beta(s)$ are the parameter estimates in the model. Equation (9) was estimated using maximum likelihood methods within the framework of Newton-Raphson algorithm in STATA. Detailed description of the predicators (explanatory variables) is given in Table 3.

Dependent variable

The dependent variable was derived from four indicators variables (*Awareness, Energy-saving practices, Choice, Conservation practice variation)* that measure efficiency of an electrical appliance. A set of questions were asked to assess respondents' level of *Awareness*: Each item is assigned a value one (1) or zero (0) depending on the response from the respondent. Hence the total score under awareness is four (4). The awareness questions are on the importance of electricity conservation, knowledge of policy, efficiency label, and information source. *Energy-saving practices* questions elicit responses on 4-point scale ratings, these are "sometimes (2)","always(3)", "rarely (1)", "I don't/Not available(0)".The maximum score under energy saving practices is 3 and the lowest is 0. The *choice* variable is measured on a 10-point scale. Items considered under this variable are; 'efficiency', 'size', 'location', 'durability', 'weight', 'cost', 'appearance', 'affordability', 'income', 'reliability'. Each of this item attracts value of 1 or 0 depend on the response from the respondent (household head). The maximum score under this indicator variable choice is 10. The *Conservation practice variation* indictor variable examines 2 items; 'income' and 'location' and this has maximum score of 2 and minimum score of 0. The four indicator measures for energy -efficient appliance are aggregated into a composite variable with highest score of 19 and the lowest is 0. Hence the index for the dependent variable is equal to Awareness(4) + Energy-saving(3) + choice(10) + Conservation practice variation(2) = 19. This is under condition that individual household head scores the highest rating for all the four indicator variables.

Table 3 Definitions of explanatory variables and expected signs

Variable	Definitions	Sign	Continuous Variable		Categorical Variable (%)
			SD	Mean	
Sex	This measures gender and social role of the household head. Male = 1 , Female = 0	±			Male(1)=35.9 Female(0)=64.1
Age	Age of the household head, both de facto and de jure in years.		14.5	40.64	
Social Stratification (Strat)	This measures zonation. Suburban areas are stratified into income levels. That is affluence :High= 1 Middle= 2; Low = 3	±			High =33.3 Middle =33.3 Low = 33.3
Marital Status	This measures whether the individual is married or not.	±			Single =32.6 Married=46.5 Cohabitation=7.3 Separated=3 .8 Widowed=6.8 Divorced=3.0
Years of Schooling (Ysch)	This total number of years' household head spent at school to acquire education /skills/ competencies.	+	5.09	9.35	
Years of Residence (Yresi)	Total number of years spent or stayed in the current residential facilities.	+	12.4	13.6	
Expend-	Daily expenditure of the households	+	21.4	39.33	

iture (Exp)			5	
Income	Total monthly income from all sources	-	200	450
Household Size (HHsize)	This measures number of individuals in the household who eat from common cooking pot and above 18 years of age.	+	2.6	6.7
BeEight	Number of individual in the household who below eighteen years of age, that is dependence ratio.	+	1.99	2.8
Hphour	Total hours in a day the households' lights are switched off.	+	0.83	1.69
Monthly Electricity Expenditure (MonEExp)	Proportion of income spent on electricity bills	+	45.8	100

Source: Based on field data, 2021

Data analysis and management

The deductive data analysis approach (multiple regression, correlation and T-test) was used for analysing quantitative data. Microsoft Excel, 19^{th} edition was used to clean gathered data and also to process data for analysis. Statistical Package for Social Science, version 23 was used to run the analysis. Results obtained from the analysis are presented in tables, graphs and charts.

Results and Discussion

Level of Educational

The study analysed educational level of household respondents in the communities as a key demographic attribute. The impact of education on the adoption of efficient technology and efficiency measures, which ultimately affect the efficiency of household electricity consumption have been studied.[48] Whereas Prete et al[49] established a positive relationship between intentions to adopt efficiency measures and higher levels of education among Southern Italian households, Poortinga et al[50] concluded in their findings that attaining higher education by household heads leads to low energy consumption. Figure 2 shows returned responses to the different levels categorized into tertiary, senior high, junior high and basic, and no formal education. Gleaning from the chart, only 13% of the respondents had no formal education (Figure 2). This is an indication that any energy conservation and efficiency awareness education policy could achieve its main goal if conscious effort is made to educate all households.

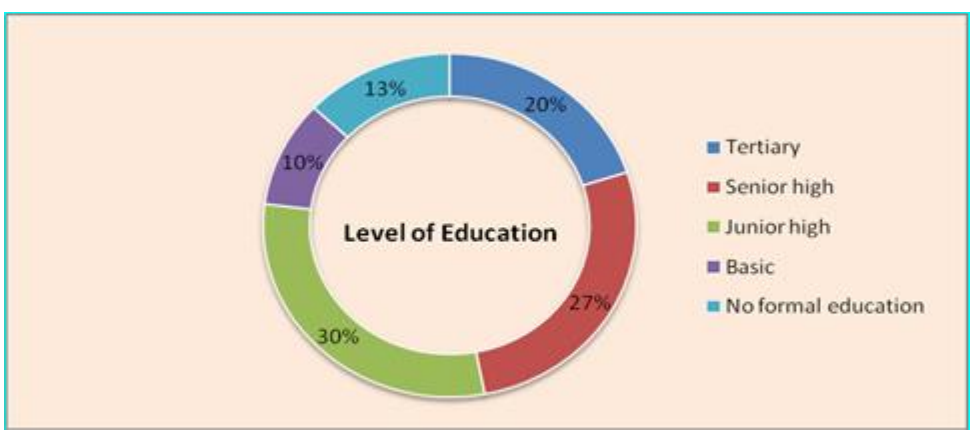

Figure 2: Level of Education
Source: Based on field data, 2021

Years of schooling is identified in the model (Table 8) to be positively associated with energy conservation behaviour of households. According to Tewathia[51] and Poortinga et al,[52] household heads with higher educational levels or achievement are more likely to be well enlightened or knowledgeable in energy conservation/saving practices. The impact of years of schooling is however observed not to be significant (P=0.017) and supports Wang et al,[53] (2011) stance that no significant difference exists in the energy-saving practices of residents across the different levels of education in the metropolis.

Household size

Figure 4 shows distribution of returned responses on household size from among five (5) accommodation types (Figure 3). Majority of the respondents (84.4%) have household sizes ranging from 1 to 6 persons. The average household size in the metropolis (Figure 4) however, falls within the national average of 4 persons per household.[8] This outcome is informing since it could be useful as statistics for planning to determine choice and use of electrical appliances in households in the metropolis.

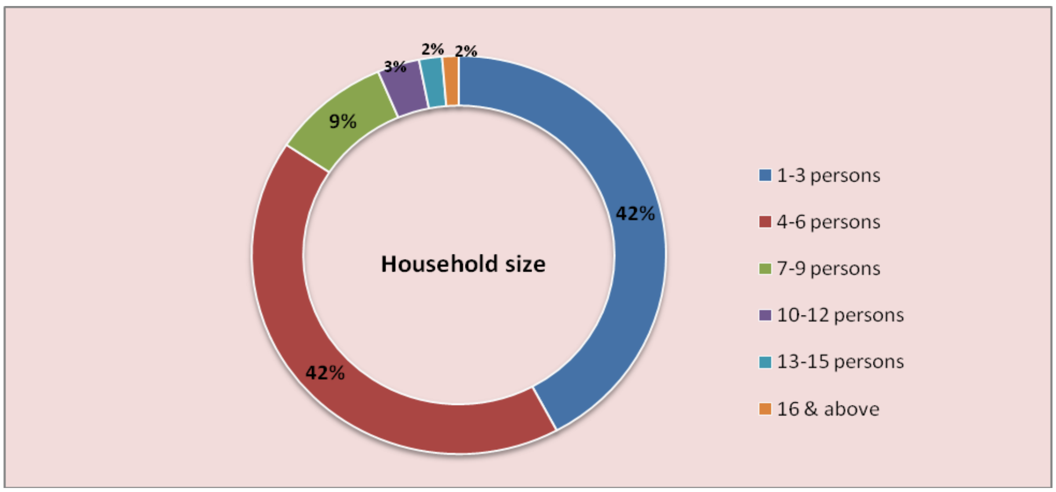

Figure 4: Household size of respondents
Source: Based on field data, 2021

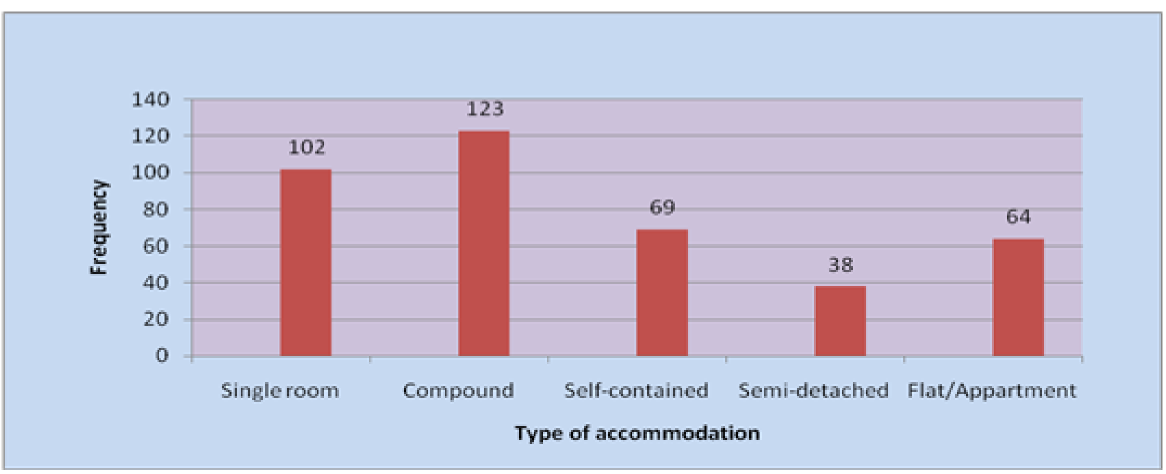

Figure 3: Respondents' accommodation type
Source: Based on field data, 2021

A number of studies, [54, 55, 56] have concluded on high energy consumption practices in households with higher occupancy rates. Jones et al[57] argues that the presence of youth in households' leads to significant increase in residential electricity consumption. From the model (Table 8), however, household size is inversely related to energy conservation practices and also significant (-0.0051189). Based on the economies of scale theory, the outcome supports Filippini and Hunt's[58] findings on the subject which explains that as family size increases, there is the tendency to use less energy per person in residential energy consumption. Households with high dependence ratio, with more members below age of 18 are more likely to adopt any conservation practices, including use of energy-efficient household appliances.[59]

Age distribution

The Cape Coast Metropolis has youthful population dynamics not different from the national average demographic characteristics.[8] Studies have shown that adoption of efficient technologies is negatively related to age[60] and that the aged are less likely to adopt efficient appliances.[48] From Table 4, majority of the respondents (82%) fall within the youthful age brackets (18-47 years). This findings collaborates assertions of Kotsila and Polychronidou[59] and Sardianou[60] on the inverse relationship existing between age and adoption of efficient appliances. Inferring from Table 8, the model shows age to be negatively (P = -0.0002008) associated with energy conservation behaviour of households but significant ($P < 0.05$). Only 13.1% of respondents' (Table 4) were found within the formal retirement age (58-63 years) suggesting that any energy conservation and efficiency education policy that consciously targets the youth will succeed in achieving its main goal.[12]

Table 4: Age Distribution

Variable	Frequency	Percentage (%)
Age		
18-22yrs	14	3.5
23-27yrs	65	16.4
28-32yrs	66	16.7
33-37yrs	51	12.9
38-42yrs	47	11.9
43-47yrs	41	10.4
48-52yrs	36	9.1
53-57yrs	24	6.1
58-62yrs	16	4
63yrs & Above	36	9.1
Total	396	100

Source: Based on field data, 2021

Household income

Income is one of the major socioeconomic variables which have significant influence on household decision to conserve energy or use energy-efficient appliance.[56] Household electricity consumption is positively related to levels of household income.[61] This implies the more income a household earns, the most likely they would be able to conserve energy or choose energy-efficient appliances. Table 5 depicts employment data in the metropolis that shows more than half of the respondents (60.9%) to be self-employed. However, they are also identified within the lowest income earner brackets (¢200-¢1200 [$32-$189]). The outcome supports data from the 2020 Population and Housing Census' report that classify majority of Ghana's economically active population as self-employed. From the model (Table 8), households' income has significant ($P < 0.001$) impact on consumption of electricity in Ghana. This implies that in order for a particular household to choose any electronic appliance, the monthly income of the household should be a determining factor.[62,63]

Table 5: Socio-demographic characteristics (Occupation and Income)

Variable	Frequency	Percentage (%)
a. Occupation		
Unemployed	47	11.9
Self-employed	241	60.9
Public servant	53	13.4
Private institution	24	6.1
Other	31	7.8
Total	396	100
b. Ave. monthly income		
GH¢200 & Below	115	29
GH¢201- GH¢700	181	45.7
GH¢701- GH¢1200	54	13.6
GH¢1201- GH¢1700	24	6.1
GH¢1701- GH¢2200	10	2.5
GH¢2201- GH¢2700	5	1.3
GH¢2701- GH¢3200	2	0.5
GH¢4201 & Above	5	1.3
Total	396	100

Source: Based on field data, 2021

Marital status

Marital status of the household head was significant and relates negatively (P= -0.052) to choice of energy-efficient appliances by the households. It is assumed that, the higher expenditure level households attain, the more likely they are to conserve electricity by choosing energy-efficient appliances. This is expected to lead to reduction in cost of electricity, cost savings to household[64,45] and climate change mitigation[63] although Frederiks, Stenner and Hobman[65] do not agree with the assertion that marital status has significant effect on energy conservation behaviours of households.

Years of residency

The relationship between years of residence and the choice of energy–efficient appliance is positive and significant (P< 0.05). This suggests that, the longer a household stays in one abode for a longer period, there is more likelihood for such household to purchase or use energy efficient appliance.[66] Literature also suggest that the older the residence of a consumer, the more likely that household will engage in energy conservation practices.[65,67] Home owners residing in older dwelling may tend to adopt greater conservation measures than those residing in newer dwellings, especially if older dwellings are in poor conditions and requires the installation of new appliances.[57]

Table 8: Socio-demographic factors influencing choice of energy-efficient appliances

Variable	Coefficient	Standard Error	Z-Statistic	Prob.
Sex	0.0308245	0.0265194^{NS}	1.16	0.245
Age	-0.0002008	0.0009946^{NS}	-0.20	0.840
Strat	-0.0234528	0.0191197^{NS}	-1.23	0.220
Marital	-0.052799	0.0116961****	-4.51	0.001
Ysch	0.0178127	0.0027238****	6.64	0.001

Yresi	0.0003079	0.0001547**	1.99	0.047
Expenditure	0.0008203	0.0001121****	7.32	0.001
Income	0.000114	0.000013****	8.79	0.001
HHSize	-0.0051189	0.0051791^{NS}	-0.99	0.323
BeEight	0.0184789	0.0098732*	1.87	0.061
Hphour	0.023367	0.0156369^{NS}	1.49	0.135
MonEExp	0.0391865	0.0084662****	4.63	0.001
Constant	2.702091	0.0768308	35.17	0.001
Number of Obs.	324			
Log Likelihood	-1320.1297			
LR Ch^2	389.92			
Prob > Chi^2	0.0000			
Pseudo R^2	0.1287			

NB: Significant levels: NS =Not significant; * P < 0.1(10%); ** P < 0.05(5%); ***P < 0.01(1%) ; ****P< 0.001(0.1%)

Energy saving practices

The study analysed energy saving practices of respondents on selected household gadgets. The main consideration was on the frequency at which electrical appliances are used in the metropolis. Respondents were asked to indicate the rate at which they '*Always*', '*Sometimes*' and '*Rarely*' switch off their electrical appliances to conserve energy when not in use. In terms of switching off electrical appliance when not in use (energy saving practice), cumulative responses on energy saving practices show that '*Sometimes*' and '*Rarely*' rated the highest across all levels of income brackets and for all the gadgets listed in (Table 6). Less than half of households who owned TVs (29.80%), light bulbs (33.90%), fridges/freezers (40.60%) and fans (38.60%) always switch off their appliances when not in use. This may support the assertion that the energy regulatory body (ECG) in the Cape Coast metropolis has been embarking on some form of energy literacy education.

Table 6: Energy saving practices among households

Electrical gadgets/household (%) N=396	Practice: Rate at which electrical gadgets are switched off when not in use (%)		
	Always	Sometimes	Rarely
TV (84.8)	29.80	61.60	8.60
Light bulb (98.2)	33.90	63.50	2.60
Fridge/Freezer (55.3)	40.60	35.20	24.2
Fan (79.8)	38.60%	46.80%	14.60%

Source: Based on field data, 2021

Ethics on conservation practices were also cited in brochures of the regulatory agencies for educational purposes. These efforts, however, need to be intensified.

Energy Conservation Awareness

To ascertain the level of awareness of households on what energy conservation is, respondents were asked to further explain what they perceived energy conservation to mean (Table 6). Returned responses indicate that households' in the Cape Coast Metropolis, to some extent, have some level of knowledge in what energy conservation is. However, the number of those who '*Don't know*' is equally worrying. This may be attributed, not only to inadequate energy conservation/savings campaigns in the metropolis, but also to the way and manner it is effectively communicated to households.

Table 7: Households perceived meaning of Energy conservation

Energy Conservation Response	Frequency	Percentage
Don't Know	187	47.3
Using available energy judiciously	117	29.5
Using energy only when needed	91	23.0
Keeping energy without using it	1	0.3

Source: Based on field data, 2021

Increase in public knowledge, using the right terms, language and medium to understand energy conservation ethics will improve energy-saving practices among households. As opined by Nunoo[68] and Amos-Abanyie et al [36] consumers put up wasteful practices due to lack of knowledge or awareness on the use of energy and its related negative implications. Poortinga et al,[52] Wang et al[53] and Kumi[69] collaborates this assertion as they scientifically prove that consumer education has significant level of influence on energy saving practice.

Energy efficiency label

The level of households' awareness on use of energy efficiency labels was assessed. Figure 5 depicts returned responses with less than half of the respondents (40%) having informed knowledge in what energy efficiency labels are. This suggest that majority of households (60%) may not be using energy efficient electrical appliances or even check for energy efficiency labels on appliances they purchased, although, these labels on electrical appliances have possibility of driving the success of households' conservation and efficiency programs.[1]

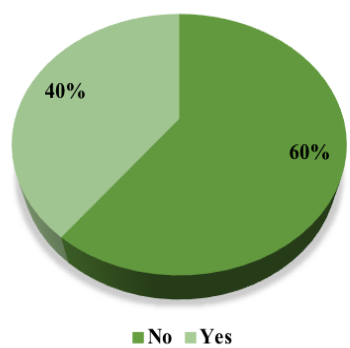

Figure 5: Energy Efficiency Label, Source: Based on field data, 2021

Conclusion and Recommendations

This study assessed energy conservation and efficiency awareness practices of households in the Cape Coast Metropolis. The level and variability in energy conservation practices and the level of energy-savings awareness education among households were examined. From the findings and accompanying discussions, it can be concluded that the level of energy conservation awareness among households is low. Although some households were able to explain what energy conservation is, majority did not know about it, attributed not only to inadequate energy conservation/savings campaigns in the metropolis, but also to the way and manner these are effectively communicated to households. The number of years spent in school by household heads, income levels, expenditure, and age of households were key factors influencing individual's choice of energy-efficient appliances. There was significant variability between existing social strata, in terms of income and use of electrical appliances among households. Based on the findings, this study recommends energy literacy to improve households energy efficiency practices and in order to ensure energy cost savings, environmental protection, climate change mitigation and the drive towards achieving the Sustainable Development Goal Seven (SDG 7). To be led by authorities of the municipality and in collaboration with the electricity distribution company, Ghana education Service and the National Commission on Civic Education (NCCE), education campaigns on energy conservation could be integrated into the municipality's routine community durbars through radio, television and the social media (Twitter, Instagram, Facebook) channels. These programmes could be intensified until households become more conversant with conservation practices.

References

1. Nunoo E.K., Mariwah S & Suleman, S. (2019) Energy Efficiency Processes and Sustainable Development in HEIs. In: Leal Filho W. (eds). Encyclopedia of Sustainability in Higher Education. Springer, Cham. https://doi.org/10.1007/978-3-030-11352-0_425

2. Commerford, M. (2011). Hydroelectricity : The Negative Ecological and Social Impact and the Policy That Should Govern It. *Energy Economics and Policy*, ETH, 25p. 2011. Available from: http://www.files.ethz.ch/cepe/Top10/Commerford.pdf

3. Harris, J.M and Roach, B. (2021). *Environmental and Natural Resource Economics: A Contemporary Approach* (5th ed.). Routledge. https://doi.org/10.4324/9781003080640

4. U.S. Energy Information Administration (US IEO). (2016). Analysis of the Impacts of the Clean Power Plan. US IEO. Washington, DC. Available @https://www.eia.gov/analysis/ requests/powerplants/cleanplan Accessed on 21 February 2022.

5. Schwartz, L., Wei, M., Morrow, W., Deason, J., Schiller, S. R., Leventis, G.,Smith, S.,Leow, W.L., Levin, T., Plotkin, S., Zhou, Y. (2017). Electricity end uses, energy efficiency, and distributed energy resources baseline. Lawrence Berkeley National Laboratory, Berkeley, CA (2017). https://doi.org/10.2172/1342949

6. Shaari, M. S., Hussain, N. E., & Ismail, M. S. (2013). Relationship between Energy Consumption and Economic Growth : Empirical Evidence for Malaysia. *Business Systems Review*, 2(1): 17-28. Available https://doi.org/10.7350/BSR.B02.2013

7. Energy Commission, Ghana. (2021). National energy statistics. Securing Ghana's Future Energy Today, Accra. Available at www.energycom.gov.gh

8. Ghana Statistical Service (GSS).(2021). 2021 Population and Housing Census. Press Release on Provincial Results. GSS, Accra. Available @ www.census2021.statsghana.gov.gh/dissemination.

9. Nunoo, E. K., Twum, E., & Essien, B. (2020). Effect of Climate Change on the Energy Sector and the Role of Artificial Intelligence (AI): Perspectives from Ghana's Nationally Determined Contributions (NDC's). *CLIMATE2020 – THE WORLDWIDE ONLINE CLIMATE CONFERENCE. 7.* Hamburg: Digital Learning for Sustainable Development. Open educational resource @ http://www.dl4sd.org

10. Kwakwa, P. A., & Adu, G. (2016). Electricity conservation behavior in Ghana: evidence from rural and urban Households in the Ashanti Region. *The Journal of Energy and Development*, *42*(1/2), 89-122.

11. Abbas, J & Brilhante, O. (2018). The influence of user awareness on user behavior in electricity consumption at Kumasi technical university (KsTU), Ghana. Erasmu University thesis report. http://hdl.handle.net/2105/46510

12. Abeney, J.O. (2018). Efficiency of household electricity consumption in Ghana. MPhil Economics Thesis, University of Ghana. Available @http://ugspace.ug.edu.gh

13. Danquah J .A., Kuwornu, J. K.M. & Pappinen A (2013). Analyses of Socioeconomic Factors influencing on-farm Conservation of Remnant Forest Tree Species: Evidence from Ghana. *Journal of Economics and Behavioral Studies* 5(9):588-602

14. Ofosu-Ahenkorah, A. K. (2007). Potential for Energy Savings in Ghana||. *Energy Crises in Ghana: Drought, Technology or Policy*, 16-33

15. Brew-Hammond, A.(1996). "The electricity supply industry in Ghana: issues and priorities." *Africa Development/Afrique et Développement,* 21, 81-98.

16. Ayres, R.U.; Turton, H.; Casten, T. *(*2007). Energy efficiency, sustainability and economic growth. *Energy* 32, 634–648.

17. Abrahamse, W., & Steg, L (2011). Factors related to household energy use and intention to reduce it: The role of psychological and socio-demographic variables. *Human Ecology Review*, 30-40.

18. Giraudet, L & Missemer, A. (2019). The Economics of Energy Efficiency, a Historical Perspective. ffhalshs-02301636f

19. Turnbull, T. (2017). 'From Paradox to Policy: The Problem of Energy Resource Conservation in Britain and America, 1865-1981'. PhD Thesis, University of Oxford.

20. Abrahamse, W., & Steg, L. (2009). How do socio-demographic and psychological factors relate to households ' direct and indirect energy use and savings ? *Journal of Economic Psychology*, *30*(5), 711–720. https://doi.org/10.1016/j.joep.2009.05.006

21. Gammon, R. B., Huning, J. R., Reid, M. S., & Smith, J. H. (1981). Urban air pollution and solar energy. *International Journal of Ambient Energy*, *2*(4), 183-195.

22. Capehart, B. L., Turner, W. C., & Kennedy, W. J. (2003). *Guide to energy management*. The Fairmont Press, Inc.

23. Ürge-Vorsatz, D., Metz, B.(2009). Energy efficiency: How far does it get us in controlling climate change? Energy Effic., 2, 87–94.

24. Plotkin, S., Zhou, Y. (2017). Electricity end uses, energy efficiency, and distributed energy resources baseline. Lawrence Berkeley National Laboratory, Berkeley, CA (2017) https://doi.org/10.2172/1342949

25.Wirl, F. (1997).*The Economics of Conservation Programs*. Dordrecht: Kluwer Academic Publishers.

26. Samuelson, C. & Biek, M. (1991), "Attitudes toward energy conservation: a confirmatory factor analysis", *Journal of Applied Social Psychology*, 21 (7), 549 –568.

27. Maistry, N., & McKay, T. M. (2016). Promoting energy efficiency in a South African university. *Journal of Energy in Southern Africa*, *27*(3), 1-10.

28. Ministry of Energy. (2010). National Electrification Scheme (NES) Master Plan Review (2011-2020). Ministry of Energy, Accra.

29. Eberhard, A. (2011). The future of South African coal: Market, investment and policy challenges. *Program on energy and sustainable development*, 1-44.

30. Kemausuor, F., Obeng, G. Y., Brew-Hammond, A., & Duker, A. (2011). A review of trends, policies and plans for increasing energy access in Ghana. *Renewable and sustainable energy reviews*, *15*(9), 5143-5154.

31. Energy Commission, Ghana. (2010). National Energy Statistics 2000- 2010. The Ghana Energy Commission, Accra. Available at: http://energycom.gov.gh/files/Energy%20Statistics_ 2015Final_1.pdf.

32. Amoah, A., Hughes, G. & Pomeyie, P. Environmental consciousness and choice of bulb for lighting in a developing country. *Energ Sustain Soc* **8,** 17 (2018). https://doi.org/10.1186/s13705-018-0159-y

33. Asumadu-sarkodie, S., Owusu, P. A. (2017). The causal nexus between energy use , carbon dioxide emissions, and macroeconomic variables in Ghana and macroeconomic variables in Ghana. *Economics, Planning, and Policy*, *12*(6), 533–546. https://doi.org/10.1080/15567249.2016.1225134

34. Gadonneix, P., Nadeau, M. J., Dickson, G., Appert, O., Ferrier, J., Cochet, P., & Joubert, P. (2013). World Energy Congress in Daegu. Uncertainties and resiliencies. November 2013.

35. Van der Werff, E., & Steg, L. (2015). One model to predict them all: Predicting energy behaviours with the norm activation model. *Energy Research & Social Science*, *6*, 8-14.

36. Amos-Abanyie, S., Kwofie, E. T., & Asare, E. S. (2016). Students' awareness of and adherence to energy management practices in selected students' halls of residence at Kwame Nkrumah University of Science and Technology, Ghana. *Journal of Science and Technology (Ghana), 36(2),96-107.*

37. Ouyang, J., & Hokao, K. (2009). Energy-saving potential by improving occupants' behavior in urban residential sector in Hangzhou City, China. *Energy and buildings*, *41*(7), 711-720.

38. Khan, I., & Halder, P. K. (2016). Electrical Energy Conservation through Human Behavior Change : *Perspective in Bangladesh*, *6*(1).

39. Sarfo, I., Shuoben, B., Beibei, L., Amankwah, SOY., Yeboah, E., Koku, J E., Nunoo, E.K & Kwang, C (2021). Spatiotemporal development of land use systems, influences and climate variability in Southwestern Ghana (1970-2020). *Environment, Development and Sustainability.* https://doi.org/10.1007/s10668-021-01848-5 https://rdcu.be/czd3r

40. Nunoo, E.K., Twum, E.K., Panin, A & Essien, B.A. (2020b). "An assessment of perceived participatory climate change adaptation initiatives in Ghana". *Management of Environmental Quality*, 32(2); 260-276. https://doi.org/10.1108/MEQ-05-2020-0096

41. Jaber, J. O., Mamlook, R., & Awad, W. E. (2005). Evaluation of energy conservation programs in residential sector using fuzzy logic methodology. *Energy policy*, *33*(10), 1329-1338.

42. Chong, E., & Dubois, U. (2010). Household vulnerability and energy conservation behavior: do the poor save less?. *ADIS, Université Paris-Sud*, *11*, 94-100.

43. Nunoo, E.K. (2014). Introduction to Research Methods & Proposal Writing. Saarbrücken-Germany. Lambert Academic Publications. ISBN: 978-3-659-58838-9

44. Glenn, D. I. (1992). Determining sample size. *A series of the Program Evaluation and Organizational Development. University of Florida. Publication date: November.*

45. Asinyaka, M. (2019). Willingness to pay for energy efficient refrigerating appliances in Accra, Ghana: A choice experiment approach. Review of Economics 70(1): 15–39. https://doi.org/10.1515/roe-2018-0007

46. Cameron, A. C., and Trivedi, P. K. (2003). Essentials of count data regression. In B. H. Baltagi(Ed). A companion to theoretical econometrics.(pp. 331-348). https://doi.org /10.1002/9780470996249.ch16

47. Cameron, A.C., and P.K. Trivedi (1998). *Regression Analysis of Count Data*. New York: Cambridge University Press

48. Broadstock, D. C., Li, J., & Zhang, D. (2016). Efficiency snakes and energy ladders: A (meta-) frontier demand analysis of electricity consumption efficiency in Chinese households. *Energy Policy*, 91, 383-396.

49. Prete, M. I., Piper, L., Rizzo, C., Pino, G., Capestro, M., Mileti, A. ... & Guido, G. (2017). Determinants of Southern Italian households' intention to adopt energy efficiency measures in residential buildings. *Journal of Cleaner Production*, 153, 83-91.

50. Poortinga, W., Steg, L., & Vlek, C. (2004). Values, environmental concern, and environmental behavior: A study into household energy use. *Environment and behavior*, 36(1), 70-93.

51.Tewathia, N. (2014). Determinants of the household electricity consumption: a case study of Delhi. International Journal of Energy Economics and Policy, 4(3), 337–348.

52. Poortinga, W., Steg, L., Vlek, C., & Wiersma, G. (2003). Household preferences for energy- saving measures: A conjoint analysis. *Journal of Economic Psychology, 24(1),49-64*

53. Wang Z., Zhang B., Yin J., Zhang Y., (2011) Determinants and policy implications for household electricity saving behavior: Evidence from Beijing, China, *Energy Policy*, 39,3550-3557

54. Baldini, M., Trivella, A., & Wente, J. W. (2018). The impact of socioeconomic and behavioural factors for purchasing energy efficient household appliances: A case study for Denmark. *Energy Policy*, 120, 503-513.

55.Zhou, S., & Teng, F. (2013). Estimation of urban residential electricity demand in China using household survey data. *Energy Policy*, 61, 394-402.

56.Yohanis, Y. G., Mondol, J. D., Wright, A., & Norton, B. (2008). Real-life energy use in the UK: How occupancy and dwelling characteristics affect domestic electricity use. *Energy and Buildings*, 40(6), 1053-1059.

57. Jones, R. V., Fuertes, A., & Lomas, K. J. (2015). The socio-economic, dwelling and appliance related factors affecting electricity consumption in domestic buildings. Renewable and *Sustainable Energy Reviews*, 43, 901–917. https://doi.org/10.1016/j.rser.2014.11.084.

58. Filippini, M., & Hunt, L. C.(2012). US residential energy demand and energy efficiency: A stochastic demand frontier approach. Energy economics, 34(5), 1484-1491

59. Kotsila, D. and Polychronidou, P. (2020). Determinants of household electricity consumption in Greece: a statistical analysis. *Journal of Innovation and Entrepreneurship,* 10(19),1-20 https://doi.org/10.1186/s13731-021-00161-9

60. Sardianou, E. (2007). Estimating energy conservation patterns of Greek households. *Energy Policy*, 35(7): 3778–3791. https://doi.org/10.1016/j.enpol.2007.01.020.

61. Zaman, K., Khan, M. M., Ahmad, M., & Rustam, R. (2012). Determinants of electricity consumption function in Pakistan: Old wine in a new bottle. Energy Policy, 50, 623-634.

62. Esmaeilimoakher, P., Urmee, T., Pryor, T., & Baverstock, G. (2016). Identifying the determinants of residential electricity consumption for social housing in Perth, Western Australia. *Energy and Buildings*, 133, 403-413.

63. Mensah, J. T., Marbuah, G., & Amoah, A. (2016). Energy demand in Ghana: A disaggregated analysis. *Renewable and Sustainable Energy Reviews*, *53*, 924-935.

64. Liu, X., Wang, Q., Wei, H., Chi, H., & Ma, Y. (2020). Psychological and Demographic Factors Affecting Household Energy-Saving Intentions : A TPB-Based Study in Northwest China, 1–2

65. Frederiks, E. R., Stenner, K., & Hobman, E. V. (2015). The Socio-Demographic and Psychological Predictors of Residential Energy Consumption: A Comprehensive Review, 573–609. https://doi.org/10.3390/en8010573

66. Ibrahim, A., Aryeetey, G. C., Asampong, E., Dwomoh, D., & Nonvignon, J. (2016). Erratic electricity supply (Dumsor) and anxiety disorders among university students in Ghana: A cross sectional study. *International Journal of Mental Health Systems*, *10*(1), 1–9. https://doi.org/10.1186/s13033-016-0053-y

67. Danlami, A. H. (2015). An Analysis of the Determinants of Households ’ *Energy Choice* :, *5*(1),197–205.

68. Nunoo, E.K. (2018). Sustainable waste management systems in higher institutions: Overview and advances in Central University Miotso, Ghana. In Leal Filho (Ed.), *Encyclopedia of Sustainability in Higher Education* (pp.500-510). Springer Nature Swizerland AG. https://doi.org/10.1007/978-3-319-63951-2_81-1

69. Kumi, E N. (2017). “The Electricity Situation in Ghana: Challenges and Opportunities.” CGD Policy Paper. Washington, DC: Center for Global Development. https://www.cgdev.org/ publication/electricity-situation-ghana-challenges-and-opportunities