KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

An Investigation into the Drivers of Household's Electricity Conservation in the Kumasi Metropolis.

By

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A thesis submitted to the Department of Economics, Kwame Nkrumah University of Science and Technology

In partial fulfillment of the requirement of degree of

MASTER OF SCIENCE IN ECONOMICS, ENERGY & RESOURCE ECONOMICS

MAY, 2016

CERTIFICATION

I hereby declare that this thesis is my own original work towards the award of master of science in Economics and that, to the best of my knowledge, it contains no material published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been in my work.

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DEDICATION

I dedicate this work to my lovely parent Mr. Issah Abdulai and Mrs. Asana Issah as an encouragement to their efforts and also to my Guardian Douglas Wilcox as an achievement to his relentless support throughout my studies.

AKNOWLEDGEMENT

I am very grateful to the Almighty Allah for his protection and guidance throughout my Studies.

I wish to thank all those who helped in this project. Special thanks goes to my supervisor Dr. John Bosco Dramani of the Department of Economics for his time, guidance and expertise support from the very beginning to the end of this work. Your consistency in reading and guidance made this study a success. I am grateful and may the good Lord replenish your time and efforts.

I acknowledge with respect the efforts and support of all lecturers of the department.

I thank all my colleagues especially my study mates for their encouragement and assistance for the successful completion of my studies.

Special thanks goes to my all my friends both home and abroad who supported me financially through my studies. I am grateful and may the almighty Lord bless you all.

ABSTRACT

This study investigates into the main determinants of household electricity conservation pattern in the Kumasi Metropolis. This study was limited to selected communities within the Kumasi metropolis which included Ayigya, Amakom, Ayeduase and Bomso one hundred household units were selected for interview. In the empirical analysis, household energy conserving choices model is employed, using a discrete and a latent trait variable respectively as a dependent variable. The results show that socioeconomic variables such as household's monthly income and

awareness on electricity conservation policies had an impact on the differences in household's conservation choices. In addition, the results showed that variables such as age, level of education, monthly expenditure and household size had no significant relationship with electricity conservation The assessment of households on their general understanding and awareness on the energy conservation and efficiency regulations were poor as majority of respondents interviewed show to have little or no enlightenment on the benefits of conserving electricity and investing into the usage of efficient appliances. Based on the results the study suggested further education to be made on the benefits of conserving electricity and the use of efficient home appliance to the households which can motivate them to take actions to conserve electricity in their home which is the predominant source of power for most households in the Kumasi Metropolis. Also policy makers and stakeholders should focus on the income of households when designing policies to model an electricity conserving behaviour as income appears to significantly influence electricity conservation.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

FIGURE PAGE

LIST OF ABBREVIATION

CFL	Compact Fluorescent Lamps
CO_2	Carbon dioxide
ECG	Electricity company of Ghana
GRIDCo	Ghana grid company limited
IEA	International Energy Agency
KTOE	Kilo Tonnes of Oil Equivalent
MW	Mega-Watt
NEDCO	Northern electricity department company
SPSS	Statistical Package for Social Sciences

CHAPTER ONE

INTRODUCTION

1.1 Background

As global energy consumption continues to increase at a rate faster than the available supplies and expected to grow at about 36% between 2011 and 2030 with fossil fuel being the major energy source, concerns about climate change has increased in recent times because of the carbon emissions that follows the consumption of fossil fuel (British Petroleum, 2013). Carbon dioxide (CO_2) which constitutes about 60% of green-house gases has been considered as the predominant cause of climate change which is emitted mainly through the production of power (British Petroleum, 2013). For this and other reasons such as energy security issues, political and socio-economic impact of rise in energy prices countries all over the world are now turning their attention towards promoting measures to ensure household energy conservation and efficiency practices as a way of curtailing energy consumption (British Petroleum, 2013).

In Ghana energy demand is increasing at a rate faster than the available supply resulting in deficit in primary energy sources. This increase in energy demand is as a result of the increase in household demand for energy mainly electricity for various domestic services and due to the growth in service sector of the economy which rely highly on power to provide various services (Energy Commission,2013).

To curtail the increasing demand for electricity which the country is not able to meet, the government of Ghana has embarked on a number of energy conservation and efficiency policies mainly to reduce household consumption of electricity and promote the use energy efficient appliances.

1.2 Problem Statement

As mentioned earlier several projects and programs have been implemented to reduce household's consumption of electricity and to promote the use of efficient home appliances. The energy efficiency standards and labelling regulation (LI1815) was passed in 2005 to regulate the use of the manufacturing, sale and use of airconditioners and compact fluorescent lamps in Ghana. The air-conditioners were chosen as first target of the regulation because of their role in the growth of peak electricity demand in Ghana. The regulation required all manufacturers, importers and retailers of home appliances such as non-ducted air-conditioners and self-ballasted lamps to label all the appliances they sell in the Ghanaian market with stickers indicating their various efficiency levels and to ensure that all the appliances conform to the efficiency standards stated in the regulation. The efficient lighting project was also implemented in 2007 under which government through the Energy Commission was able to collect and replace incandescent lamps with Compact Fluorescent Lamps (CFL). This project was able to save the country about 124MW of electricity equivalent to about $300 million if government were to invest in providing a thermal plant to produce electricity to meet the demand for power (Energy commission,
2010). Aside this regulation government through the efficiency regulation (LI 1932, 2008) is prohibiting the importation of inefficient used or second hand home appliances. These second-hand appliances includes used refrigerators-freezers, freezers, incandescent lamps, used Television sets etc. which are considered as the appliances that results in high household demand for power (Energy Commission, 2010). Following the ban of the importation of used refrigerators the energy commission also embarked on a refrigerator rebate and exchange scheme to phase out second-hand refrigerators from the Ghanaian market. Under this scheme owners of used refrigerators

are given some discount to purchase new and efficient refrigerators and freezers. Other stakeholders like the financial institutions are playing a very important role in the move towards efficient home appliance in the country by giving credits at low interest for owners of used refrigerators to purchase new and efficient ones. This scheme is expected to save about 216MW of electricity for the country which is more than half of the 400MW of power generated by Bui dam (Energy Commission, 2013). In an effort to achieve a behaviour change among households, the government through Energy Commission and other stakeholders has embarked on numerous public education and awareness creation on appliance energy efficiency characteristics, standards and labels and the cost and benefits of using efficient appliances (Energy Commission, 2010).

Despite these efforts by government to ensuring energy conservation and energy efficient appliance use in the country there is evidence that household demand for electricity is still increasing which has also contributed to the recent power outages. The statistics on electricity generation and consumption in the country showed an increasing trend in electricity consumption in 2013 (Energy Commission, 2014).

Figure 1.1 is trend graph of the total electricity consumption and total electricity generation between 2001 and 2014 and this exhibits an upward trend. This movement clearly shows that if measures are not put in place to ensure effective implementation of the current energy conservation and efficiency regulations there is a high tendency for total electricity consumption to increase beyond current generation capacity.

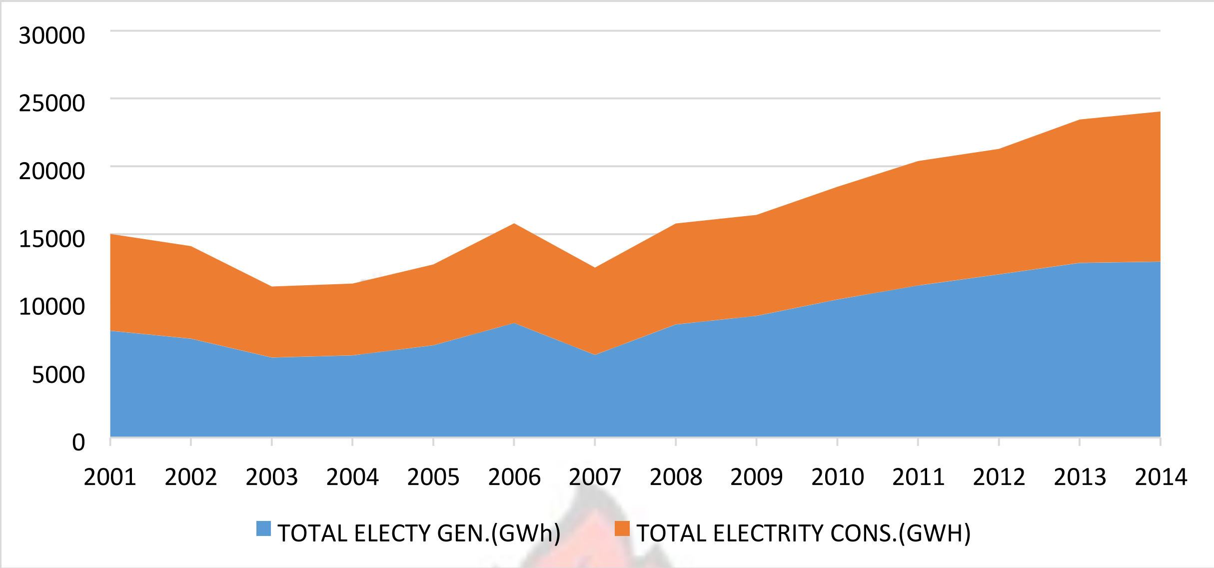


Fig 1.1: Trend of Electricity Generation and Consumption in Ghana (2001-2014)

Source: Energy Commission (2014).

The growth in electricity consumption is attributed to the increase in demand in the commercial, industrial and residential sector of the economy. But a higher percentage of this increase in electricity consumption is driven by residential sector of the economy which uses about 48% (433.2KTOE) of electricity in 2013 (Energy Commission, 2014).

This increasing trend in electricity consumption mainly driven by households or residential consumption means that the government efforts to curtail increasing electricity consumption through behaviour modification and efficient appliance use is not yielding positive results. This research therefore aims at investigating to identify the key drivers that affect household's choices on electricity conservation actions and to evaluate the degree of awareness of households on energy conservation policies in the country.

1.3 Purpose of Study

The significance of this study is to contribute to the body of knowledge on electricity conservation and efficiency. The study highlights the most important factors that affect household's choices on electricity conservation which can be taken into consideration by policy makers when selecting measures to ensure household's electricity conservation in Ghana.

By assessing the degree of awareness of households on conservation and efficiency regulations in Kumasi metropolis, this study will inform policy makers and stakeholders on level to which they have succeeded in various educations on electricity conservation and how that has impacted on households electricity conservation behaviour.

1.4 Research Questions

The research questions were:

- What are the key determinants of household electricity conservation in Kumasi Metropolis?
- What is the degree of awareness of Energy conservation policies in Kumasi Metropolis?
- What type of appliance use and changing behavior affects electricity demand in Kumasi Metropolis?

1.5 Main Objective

To investigates into the key drivers of household's electricity conservation in Kumasi Metropolis.

1.5.1 Specific Objectives of Study

The objectives of the study were:

- To identify the key determinants of electricity conservation in Kumasi Metropolis
- To ascertain the level of awareness of households in the Kumasi Metropolis on energy conservation policies in Ghana.
- To examine appliance use and analyze how changing behavior and appliance use affect electricity use in the Kumasi Metropolis

1.6 Organization of the study

The entire research is divided into five chapters, chapter one consist of the background to household's energy conservation which addressed all historical accounts and current knowledge on the topic. Chapter two consist of a critical review of concepts as well as the drivers of energy conservation choices and an empirical review on the topic. Chapter three consist of the methodology and data section which includes the specification of econometric model and the definition of variables captured by the model. Chapter four will be results presentation and Analysis. And finally chapter five consist of summary of findings, conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section of the study reviews various literatures on theoretical and empirical studies on energy conservation. This chapter is divided into four sections, the first section includes the theoretical framework on energy conservation and efficiency. The second section consist of the theoretical background of determinants on energy conservation.

The third section consist of a review of the econometric model used to estimate the determinants of household energy conservation and the last section is conclusion.

2.2 Theoretical Framework of Energy Conservation

This section of the chapter reviews various literatures on the conceptual framework of the subject topic and this includes energy conservation, Energy efficiency and the Rebound or Take-back effect.

2.2.1 Energy Conservation

According to Munasinghe and Schramm (1983) energy conservation is defined as "the deliberate reduction in the use of energy below some level that will be prevailing otherwise". The International Energy Agency (2014) defines energy conservation as "limiting or reducing energy use or consumption through change in lifestyle or behaviour. Linares and Labandeira (2010), defined energy conservation as the absolute curtailment of energy consumption compared to a certain benchmark measured in energy units. It involves a deliberate trade-off of comfort and may sometimes deprive the vulnerable section of the population (Bhattacharyya, 2011).

Energy conservation is also considered as the typical reduction in total amount of energy consumed (Gillingham et al., 2009). Thus energy conservation may or not be necessarily associated with energy efficiency (Gillingham et al., 2009). This implies that energy consumption can be reduced with or without an improvement in energy efficiency. It involves a deliberate change in consumption lifestyle.

2.2.2 Energy Efficiency

Energy efficiency is usually given different meaning by different users depending on the users understanding or the focus of their analysis. In thermodynamics energy efficiency is defined as the ratio of heat content of an output to that of an input (Bhattacharyya, 2011). The lower the ratio the less efficient the appliance is and vice versa. This definition however does not differentiate between low and high quality of energy. This is because different energy source produces different levels of productive output. For example electricity is relatively high in quality and may have a high level of productive output than a low solar energy (Bhattacharyya 2011). The thermodynamic definition of energy efficiency becomes less applicable outside the engineering design. In an economic context energy is considered as an input into the production of a desired level of energy services (e.g heating, cooling, lighting and motion) but not an end in itself. In economic analysis energy efficiency is considered as the services provided per unit of energy input (Gillingham et al., 2009). For example the energy efficiency of an air conditioner is the amount of heat the air conditioner can recycle per kilowatt hour of electricity input. It is also considered as one of the bundle of product characteristics, product cost and other attributes at the individual product level (Gillingham et al., 2009). Thus at the household level it may be considered as cost of improving energy efficiency by investing in energy efficient appliance which comes with a long-term economic benefit of low operation cost or energy saving. At the aggregated level it is considered as the level of gross domestic product per unit of energy consumed in an economy's production (Gillingham et al., 2009). However it is very important to distinguish between energy efficiency and economic efficiency. Maximizing economic efficiency will mean maximizing net economic benefit to society but this term does not imply maximizing energy efficiency because energy efficiency is a physical concept and comes with cost and it is driven by private decisions (Gillingham et al., 2009). Nevertheless there are concerns about whether the private decision regarding energy efficiency is economically efficient. This will depend on the economic efficiency of the market the consumer faces and the economic behaviour of the individual in terms cost minimization and utility maximization (Gillingham et al., 2009).

2.2.3 The Rebound Effects (Take-back effect)

Increased improvement in energy efficiency does not necessarily mean increase in energy savings but may lead to an increase in energy consumption which is referred to as the 'take-back' or rebound effect. The effect of this is that it may negate energy savings and increase energy consumption which is usually induced by a reduction in implicit price of energy products resulting from an improvement in energy efficiency (Stephanie, 2010). Bhattacharyya (2011), defined rebound effect to imply the part of energy saved that manifest itself in high energy consumption. An increase in energy efficiency may result to an increase in demand for energy service which is induced by a decline in marginal cost of energy services. There appears to be three primary types of rebound effect (Stephanie, 2010, Bhattacharyya, 2011).

2.2.3.1 The Direct Rebound Effect

Occurs when the demand for energy services increases resulting from an increased energy efficiency. An example is purchasing energy efficiency lamps but leaving them on for a longer period of time. It is also considered as an increased in energy consumption resulting from a fall in energy products price as a result of improved efficiency.

2.2.3.2 The Indirect Rebound Effect

Occurs when there is a reduction in the real cost of energy services resulting from an increase in households or individuals real income which partly because of the savings made through energy efficiency improvement. This increases the consumer purchasing power and hence he or she can purchase more goods and services including energy service. An example is if the increase in purchasing power encourage individual to purchase more energy intensive good like buying an additional air conditioner.

2.2.3.3 The General Equilibrium Effects

This result from a general increase in supply and demand involving all producers and consumers in all sectors. This covers production and consumption at the macro level of the economy.

2.3 Household Behaviour and Energy Use

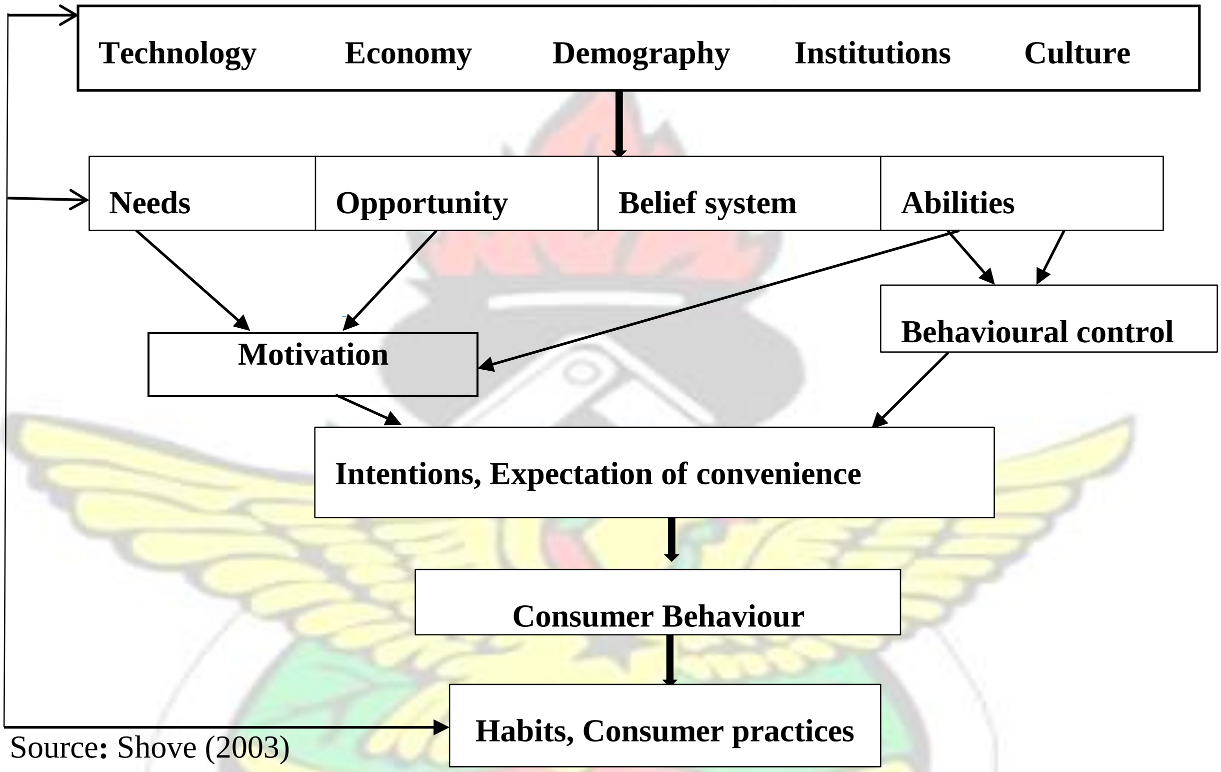
Most energy efficient measures implemented across the world involve technological intervention but the success of these measures depends highly on people adjusting their energy consumption behaviour.

Household behaviour towards energy consumption is mainly determined by the actions and decisions of the occupants and these actions are motivated by some psychological, social and economic factors. It is therefore important to understand these factors and how they influence household behaviour and choices in their consumption of energy. Several studies on household energy conservation focus on the household behaviour, the drivers of household behaviour and how that affects their energy consumption. In sociology many studies have emphasized on what factor and circumstance create certain type of energy use behaviour for example household's attitudes on energy efficiency and Eco friendliness. Social and psychological factors related to energy-saving behaviour and their relationship to cognitive variables such values, social norms and beliefs has been the focus of many studies (Gardner and stern, 1996).

A number of studies suggest that social factors could be an important determinant of energy conservation behaviour. A social norm is defined as an expectation shared by a group which is considered as appropriate for a given situation (Secord and Backman, 1974). Roger and Shoemaker (1971) also defined norms as an established behaviour pattern for members of a given societal system. O'Riodan (1971) refers that attitudes are organized sets of feelings and beliefs f about a subject or situation, which can influence an individual's behaviour. According to Becker and Seligman (1981) it is important to examine attitudes because "appropriate energy related attitudes and beliefs might constitute a necessary condition for appropriate energy related behaviours". Since new attitudes can be established, attitude-action association has important implications for energy education (Collins et al., 1979).

Some researchers have begun to speculate on the above mentioned factors whiles others have begun to provide relevant evidence. Using econometric analysis researchers have found that beliefs and behavioural intentions closely related to specific energy-using behaviour are predictive of these behaviours. Respondents perceived their use of energy according to their judgment of the effect of energy conservation on personal comfort and health, the effort required to conserve and the monetary payoff for doing so, the ability of the individual to have an impact on the energy problem and their belief that the crisis is legitimate. Contrary to Seligman et al. (1979) results, Ritchie et al. (1981) survey for 2.366 Canadian households proved that none of the attitudinal variables was significant in the final explanatory model of actual energy consumption. Verhallen and van Raaij (1981) argued that people's perception of their own contribution to energy problems is predictive of household energy conservation. Presumably, the greater the perceived seriousness of the problem, the more likely one should be to support strategies for promoting energy conservation (Olsen, 1983). Shoves (2003), argues that there is evidence that routine energy consumption is to a large extent controlled by social norms and is profoundly shaped by culture and economic factors. Fig 2.1 summarizes the factors influencing consumer energy consumption choices and how that affect conservation practices.

Fig 2.1: Factors influencing consumer behaviour and emergence of consumption practices



Source**:** Shove (2003)

The consumption habits of a consumer according to Shoves (2003) as depicted in the diagram is determined by a multidimensional factors including technology, demographic, Institutional and culture which constitute the fundamental factors and captured at the top of the flow diagram. All these factors influences consumer's needs and belief system and determines the opportunities and abilities of a consumer which further motivates or compel the individual to make a decision based on intentions and expectations to achieve certain convenience or benefits. This means that an individual's decision to conserve electricity or use energy efficiently is determined by a multidimensional factors that influences his or her decision to conserve or do otherwise.

2.3.1 Household Appliance Use and Energy Consumption

Several study into household energy conservation tries to examine the appliances used in the homes of individual households because various energy sources are used to derive some level of services through appliances and these appliances uses a certain amount of energy to deliver these wide variety of services (Sardianuo,2007). Thus the number of appliances, the efficiency and the rate at which they are used in various home influences the consumption of energy and affects household's conservation behaviours. Examining these household characteristics has been one of the focal point of most studies on household energy conservation (Sardianuo,2007).

According to IEA (2014) household appliances such as refrigerators, freezers, washing machines, dish washers and television accounts for about 59% of household's electricity consumption in OECD countries. The increased in ownership of small miscellaneous appliances such as personal computers, mobile phones, personal audio equipment is also responsible for increase in household energy consumption in OECD countries (IEA, 2014).

A study of household appliance use in Ireland by Leahy and Lyon (2009) showed that increase in household's energy consumption in Ireland mainly driven by electricity consumption was attributed to the increase in demand for household appliances between 1994 and 2004. Residential appliance and equipment represents one of the fastest growing energy load and increase in ownership of small miscellaneous appliances such as smart phones and other audio equipment is estimated to have consumed over 616 terawatt of electricity in the world in 2013 (IEA, 2014).

Shipper and Hawk (1991) argued that more appliance ownership by household were going to increase household energy demand unless they invested in purchasing efficient appliances which consumes relatively less energy for a higher energy services. Contrary to this argument, others studies show that increase in household energy efficiency by investing in more energy efficient appliances is likely to increase the household energy demand through the rebound effects (Gillingham et al., 2009). Some researchers did not only emphasized on the number of appliances held by households but also considered the households or occupants behaviour towards the use of these appliances by examining the frequency or the rate of use of these appliance. In a social science study of household behaviour and energy consumption by Shove (2003), it was clarified that the part of the behaviour of members of a household to frequently enjoy comfort, convenience and other satisfactions from the services of energy increases household energy consumption.

2.4 Household's Income and Energy Conservation

Several research works have investigated the lifestyle and energy use interaction by looking at the underlying socio-economic variables such as income and its effects on energy conservation. Held (1983) argued that household income is a major predictor of energy use behaviour which was in conformity with the results of previous research by Ritchie *et al* (1983) which concluded that there is a positive relationship between household income and energy consumption. Recent studies has it that households with higher income tends to consumes more energy sources because they have the purchasing power to acquire various forms of energy (Brandon and Lewis, 199). Contrary to this, Olsen (1981) argued that the relationship between household annual income and the acceptance of energy conservation strategies is described as being insufficient and weak in predicting effective household conservation behaviour. Other studies have also found negative relationship between household income and energy conservation Cunningham and Lopreato, 1977; Opinion Research Corporation, 1975c). Despite these contradictions most works still confirms the positive relationship between household income and energy conservation. In an econometric estimation of household conservation Sardianou (2007) proved that household income was largely positively and statistically related to energy conservation. This is because there is a positive relationship between the income allocations to investment in energy conservation practices (Long 1993). Others have gone further to investigate social class of households and its relationship with energy conservation and conservation behavior is found to have a positive relationship with household's social class (Bultena, 1976). This is true because household class has a positive relationship with income as income is always the yardstick to classifying people in the society. Thus households with higher income are ranked as the rich or the upper class in the society and have the ability to respond to greater energy conservation activities.

However Kasulis *et al* (1981) had argued that if a household belongs to a low income class or group then they are very likely to be using low amount of energy and will not have the ability to respond to greater energy conservation activities. Stern and Gardner (1981) argued that the use of efficient measures is more preferable to the reduction or curtailment measures by households with high incomes. Thus technical improvement is more acceptable for high income consumers but behavioral measures is least acceptable for high income households (Poortinga *et al*, 2003). Wealthier households purchases services and luxuries which are less energy intensive (Lenzen *et al.*, 2006). Households with lower incomes and expenditure in contrast live in less energy efficient buildings and often utilize older appliances with lower energy efficiency and rating (Clancy & Roahr, 2003). Households with lower incomes rather prefer low and cheap appliances which are relatively energy inefficient. In Ghana the second-hand refrigerators and other second hand electrical devices which are relatively inefficient are purchased by low income households (Buskirk, *et al.,* 2007).

Another dimension to which the positive relationship between the income and energy conservation and efficient activities may break has to do with appliance ownership. Higher households appliance ownership have been attributed to higher income and expenditure which always results to higher energy consumption (O'Neill & Chen 2002; Abrahamse 2007; Roberts 2008; Abrahamse & Steg 2009; Sovacool & Brown in press). However it is generally assumed that households with lower income owns less household appliances and hence are compelled to conserve. Again for some type of services households seeks to derive from the consumption of energy the positive relationship between households income and conservation may be negative, for instance home heating conservation and income has appeared to have a negative association in most studies (Morrison & Gladhart, 1976; Murray et al., 1974; Perlman & Warren, 1975a, 1975b; Reizenstein & Barnaby, 1976). This is true because of the underlying factor of home heating may be associated to weather which is an external factor and households with higher income tends to invest more in heating appliances which leads to a high energy consumption.

2.5 Price of Energy Products and how its Influence Household's Conservation Decision

Another very important variable that has an effect on energy conservation and efficient behaviours of households is the price of energy product. Several research have been undertaking to ascertain the correlation between energy prices and energy conservation and efficient practices and a lot of researchers have emphasized on how important energy prices is on the energy conservation behaviour of households. Long (1993) proved that there was a statistically significant relationship between energy price changes and conservation measures that individual households in American were likely to use. He found that for each percentage increase in the cost of energy resulting to a 0.21 rise in conservation items or appliances. Also his studies revealed a positive relationship between increased expected prices and the total conservation expenditure. Walsh (1989) confirmed a positive relationship between probability of household's energy conservation improvement and the increase in high prices of fuel after a survey of 2.911 Californian households. Pit and Wittenbach (1981) also found the same results of a positive relationship between energy conservation improvement and expected price increase. However increase in energy prices usually drags up prices of other goods and this will imply a rise in cost of conservation improvement. This is because energy efficient equipment may become expensive when price of energy increases. Schipper and Hawk (1991) acknowledged that although energy efficient appliances may be costly at the time of purchase households in the long run ignores that conservation appliances are less expensive in use due to the repressive use of high price of electricity. Other researchers have argued that energy price hikes do not always motivate conservation activities. Dillman et al (1983) found, by investigating the behavior of 8.392 households in the United States, a high energy prices motivated the wealthy households to invest in conservation measures whiles the poor cutback their entire expenditure as a result of increase in energy prices. The socio-economic and equity implication of energy price increases influence the nonvoluntary character of households energy conservation measures (Held, 1983).

2.6 Age as an Estimator of Energy Conservation

Various empirical studies examined Age of respondent as an estimating variable for household energy conservation behavior. Lenzen et al (2006) clarified that age may exert great influence on energy consumption as older age use more vehicles for mobility. To maintain the health of both children and the elderly people, both heating and cooling devices will have to be switched on for a longer periods each day and higher than normal indoor temperatures (O'Neill & Chen 2002). It has been found that energy consumption varies among age groups. In Germany younger women has a high propensity to consume more energy than the elderly women. Energy conservation between the two age groups varies in terms of methods; Elderly women change their behaviour directly by reducing their consumption while the younger women prefer the use of energy efficient or technological means to reduce their energy consumption. In the study of Canadian households Walsh (1989) found that the younger household heads are more likely to make conservation measures than the elderly people. He reiterated that investment in conservation measures is less likely to be made by the older people as they do not expect a significant rate of return from energy improvement as do their other age cohorts.

Semenik et al (1982) argued that many energy conservation behaviors such as walking, bicycling, turning down winter thermostats and turning up summer thermostats may be less feasible for people with poor health which is why the elderly people do not see the essence of conserving energy since poor health traits is common within the elder age. In earlier study for a Canadian and UK consumers, respectively, Ritchie et al (1981) proved that age was positively related to household energy consumption.

Other studies proved otherwise as Hierst and Goeltz (1982) argued that age has a curvilinear relationship with energy conservation behavior because the young and elderly people take few conservation actions than the middle age cohorts. In general the older a person is the less likely he or she is to adopt energy conservation measures because(Sardianou,2007): (i) the housing of the elderly are older ones with decayed insulations (ii) elderly diminished physical ability to conservation improvement (iii) elderly have fewer years of formal education and lack of energy know-how. In contrast with the previous arguments of a negative and curvilinear relationship between age and household conservation actions, Long (1993) estimations on energy conservation expenditure of Americans in 1981 showed a positive relationship between the age of respondent and the expenditure allocated for investment into energy conservation measures. This is true because of the older and less energy efficient houses elder people reside in. early studies confirmed the results of positive relationship between age and energy conservation including Cunningham and Lopreato (1977) who found that the oldest and the youngest are most likely to conserve energy and also found that there was a positive relationship for certain conservation action and age and for others there was a negative relationship. Other studies reports no significant relationship between age and energy conservation

(Hogan, 1976).

2.7 Household's Characteristics and how it Influences Energy Use

Numerous investigations have been conducted to ascertain how general features of household such as the building type and the number of occupants affect household energy conservation decision making. Doherty et al. (2008) argued that there was a positive relationship between the market value of homes and the improvement in energy-savings features in various home in Ireland. They clarified that an increase of

£100,000 market value of a home is likely to increase energy-saving features by 3.4%. Also houses including detached and semi-detach dueling's use about 74% more electricity than residential units (Halloway and Bunker, 2006). Houses that tend to have large size with more floor space will require more energy to heat, cool or light the space. This results confirms the earlier research which concluded that households residing in large dwellings as measured in number of rooms and number of floors are energy intensive (Ritchie et al, 1981).Finally the size of family or occupants has been observed to have a positive relationship with in-home energy consumption with households comprised of two to four people taking a greater number of conservation actions than those of differing size (Curtis et al., 1984).

2.8 Level of Education of Household and how it Influences Energy Conservation.

Several investigations into the relationship between education and energy conservation attitude revealed a positive relationship between education and energy conservation (Stephanie, 2010). Poortinga et al. (2004) for example, argued that a higher level of education may be associated to a lower level of energy usage. Leahy et al (2009) concluded that domestic appliance ownership may be linked to the level of education held by households head. Those with lower level of education are less likely to own fridge / freezers, washing machines microwave dishwashers (Leahy & Lyons, 2009). This trend between education and ownership of energy appliances is because of the positive correlation between education and income; those with higher levels of education are often employed in jobs and earn high salaries than those with low levels of education who earn relatively low salaries and therefore restricted in terms of overall household budget (Leahy & Lyons, 2009). This positive relationship was found in early research into the subject area, Held (1983), found that energy use and acceptance of energy conservation was positively related to the level of education held by respondents. However other researchers argue an inconclusive relationship between education and energy conservation behaviour (Stephanie, 2010).

Gatersleben et al. (2002) have suggested that education is not notably related to energy consumption. There are other exceptions which include a curvilinear relationship between education and conservation actions (Cunningham and Lopreato, 1977).

2.9 Effects of Information Diffusion on Energy Conservation Behaviour

One of the questions that puzzle researchers their investigation into energy conservation is why households gives less attention to energy conservation despite the fact that it is an efficient energy use behaviour in an economic perspective. Information on the need or importance to practice conservation action became central to most researchers which were evaluated to ascertain the level of information and its impact in the modifying household's energy consumption behaviour.

Information dissemination is one of principal approach employed to achieve a reduction in household energy consumption (Stephanie, 2010). Information diffusion is a psychological strategy which is often based on the provision of information which it aimed at changing individual's knowledge perception and habits (Stephanie, 2010).

It is generally assumed that mental change can induce consumption behaviour (Steg, 2008). Information diffusion tends to be a voluntary and communicative way of activating energy conserving behaviour (Held, 1983).

There are various ways to diffuse information to alter the behaviour of individuals; some of the effective ways includes pamphlets enclosed in utility bills, advertising energy conservation and efficiency campaigns and energy-appliance utilization labels

(McDougal et al, 1981). The purpose of this is to improve the recipient-household knowledge on the importance or need for conservation actions through persuasive, emotional and supportive messages which can drive individuals to take such actions (Olsen, 1981).

Sardianuo (2007), stressed on the source of information as also a crucial factor in altering the behavior of individuals in terms of energy consumption. Every form of information such as feedback information, general information, specific and behavioral information can be evaluated in the process of energy conservation campaign (Van Raaij and Verhallen, 1983). Curtis et al (1984) suggested that the number of sources people utilize to gain information is positively related to energy conservation actions. Although there have been some successful informational strategies implemented (Benders et al. 2006), more often than not, inducing behaviour through the use of information has done little in behaviour modification (Steg, 2008). Interestingly, previous research in Belgium concluded that households with greater understanding on climate change do not act in more environmentally sustainable way (Bartiaux 2008).The less impact of information in changing behaviour in the short term may be attributed to lack of the understanding of the cost and benefits of energy efficiency improvement (Schipper and Hawk, 1991). However information strategy tend to be relatively effective if the change of behaviour requested is relatively cheaper, easy and does not take much time and generally accepted and does not limit the lifestyle of the individuals (Steg, 2008).

2.10 Econometric Framework on Drivers of Household's Energy Conservation

Since energy conservation is a form of energy consumption behaviour by households majority of early studies (e.g. Olsen, 1981; Black et al, 1985) tried to use discrete choice model to estimate the relationship between the energy conservation behaviour or household energy consumption choices and the factors that influence these choices. Early studies on energy conservation focused on finding means of specifying the relationship between appliance stock and the rate at which it is utilized in an appropriate manner. As data on information relating rate of appliance use and the cost of appliance became more readily available researchers attempted to build a model which analysed electricity consumption conditional on information about stock of appliance and their rate of utilization. These models became known as conditional model. The models recognized the derived nature of energy demand either by specifying a separate demand function for appliance stock and utilization rate or appliance stock held constant and focus on the determinants of the utilization rate which tried to reveal the household energy consumption behaviour. This two separate analysis became known as the structural model which analyses household energy consumption behaviour by a given appliance stock and end-use model which tries to develop a model which estimates household energy consumption behaviour using the appliance use rate. The Houthakker (1951) and Fisher and Kaysen (1962) studies are considered by Madlener (1996) to be examples of the early attempts to model household electricity demand given appliance stock.

Given certain household choices, such as alternative energy uses of appliances, the advantage of using this approach became apparent. These models don't only look at the decision of how much to consume but also look at the decision as to the type of appliance purchased (Eakins, 2013). Thus energy consumption behaviour of household is modelled in two stages, based on the static and dynamic modelling of the energy using appliance stock and second based on the modelling of the utilization rate of the appliance stock.

Hausman (1979) was one of the first to apply such a model. Using data on both the purchase and utilisation of room air conditioners, he applied his model to a sample of US households for the year 1976. The main purpose of the study was to analyse the trade-off that households make between the initial capital costs of more energy efficient appliances and operating costs for the appliances, i.e. between future and present costs. Hausman (1979) found that individuals apply a high discount rate in making the trade-off decision implying that they value the benefit of cheaper initial capital costs over the benefits of lower future operating costs. Using a qualitative choice specification was especially beneficial in this instance as it allowed for a comparison to be made on the degree of substitution between air conditioners which had different attributes i.e. energy efficiency and operating costs. Recent studies on drivers of household energy conservation in Kenya by Mutua and Kimuyu (2015) used logistic model to estimate the main determinant of household energy conservation behaviour for different energy sources. In their studies the dependent variable which they treated as a dichotomous variable was measured in terms of energy savings measured in money equivalence and also a latent variable measuring household energy conservation behaviour in which household either adopt conservation behaviour or not. Other Studies by Sardianuo (2007) also adopted the discrete choice model to estimate the drivers of energy conservation behavior by establishing a model between a latent variable measured in terms of efforts put in place by household to ensure energy conservation and the socio-economic and demographic variables that induces household energy conservation. She argued further that discrete model was essential for the analysis because of the qualitative nature of the dependent variable. This was also confirmed in the empirical studies by Wang et al (2015) on the determinants of household electricity efficiency improvement in which logistic model was used to examine the factors that influence energy efficient behaviour given the binary nature of the dependent variable.

2.11 Energy Consumption in Ghana

The primary sources of energy in Ghana consist of electricity fossil fuel and biomass and locally energy production is mainly derived from biomass sources, hydroelectrical dams and thermal plants and sun. The country import electricity, fossil fuel and crude oil to supplement its production in order to meet demand. This energy is supplied to various sectors of economy including residential sector, Transport sector, Agriculture and fishery sector, service sector and the industrial sector.

The annual growth rate of the demand for electricity in Ghana is between 6% and 7% and the demand for petroleum products is also growing at the rate of 5% per annum (Energy Commission, 2010). Energy production on the other hand is characterized high level of inefficient transportation and distribution resulting to system losses in electricity at about 25% and wastage at the end-use of electricity is also estimated at 30% (Energy Commission, 2010). This loses in electricity due to inefficient generation, distribution and usage is accountable for the worsening erratic power supply in the country resulting to decline in production in most parts of the economy and which translate into low GDP growth. Ghana in recent times have realized a tremendous growth in the production of electricity but this has not translated very well into the improvement in economic growth as the annual GDP of the country is still low compared to previous years(Energy Commission, 2013). This implies that more of the electricity produced is lost in the distribution and use channel.

2.12 Energy Conservation and Efficiency Policies in Ghana

The government of Ghana through various Agencies and stakeholders have designed and implemented some policies to counter the inefficient distribution and use of energy. This policies range from incentive base to mandatory measures adopted to regulate demand for energy products in the country. In order to understand the policies it is very important to look at the Agencies that serve as major players in both the supply side and demand side of energy in the country.

The main actor of the energy sector in Ghana is the Ministry of Energy which is responsible for the broad formulation of policies, programs and projects for the entire sector. Other bodies or agencies serves as subordinate in the implementation of policies and projects in the entire sector. In the power generation, transmission and marketing sector the main actors include the Volta river authority, the Bui power authority, Sunun Asogli power plant, Ghana grid company limited (GRIDCo), Electricity company of Ghana (ECG) and the Northern electricity department company(NEDCO). The regulatory institutions include Energy commission, Public Utility and regulatory commission and the Ghana Energy foundation which is a nongovernmental organization devoted to the promotion of energy efficiency and renewable energy in Ghana.

The Ghana energy and efficiency policy is a section of the broader National energy policy which was designed to address all issues in the energy sector of the economy.

The goal of the energy efficiency and conservation policy is to ensure efficient energy production, transportation and use of energy in Ghana (Energy Commission, 2010). The policy aims at 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 (Energy Commission, 2009).

2.12.1 The Efficient Lighting Project 2007

Ghana in an effort to achieve the policy directions of the energy efficiency and conservation policy, implemented the efficiency lighting policy in 2007 under which the government on the advice of energy commission was able to procure and distribute for free 6 million Compact Florescent Lamps (CFL) in order to replace the estimated 6 million incandescent lamps commonly known as onion bulbs as a load reduction strategy to reduce the power shortages in Ghana (Ministry of Energy, 2011).This has resulted to the reduction in the use of light crude to power thermal plants by 148, 000 barrels and saved about 112320 tons of Carbon emissions (Energy Commission, 2013).

2.12.2 The Energy Efficient Standards and Labelling Regulation (LI 1815, 2005)

Another energy efficiency policy is the efficiency standards and labelling regulation LI 1815 which was passed in 2005 to ensure the labelling of all electric appliances such as non-ducted air conditioners and self–ballasted lamps (Energy Commission, 2005). The law required manufacturers, importers and retailers of non-ducted air conditioners and self-ballasted lamps to abide by efficiency standards and are also required to label their appliances with stickers which shows the various efficiency rating of the various appliances sold in the domestic market (Energy Commission, 2005). The table below shows the efficiency rating for non-ducted Air conditioners and self –ballasted lamps

Table 2.1 Energy Efficiency Rating for Non-ducted Air-conditioners

ENERGY EFFICIENCY RATING	NON-DUCTED AIR-CONDITIONERS

5-Star	4.00<EER
4-Star	4.00≥EER>3.75
3-Star	3.75≥EER>3.45
2-Star	3.45≥EER>3.15
1-Star	3.15≥EER>2.80

Source: Energy commission (2005)

The minimum energy efficient standard for air-conditioners to be accepted in the country is an energy efficient ratio (EER) of 2.8 watt of cooling per watt of electricity input and air-conditioners with EER of 3.5 and above are those found in the market (Energy Commission, 2005). The Stars measures the degree of efficiency of airconditioners available in the market for sale. Hence the higher the number of stars the more efficient the air-conditioner (Energy Commission,2005).

Table 2.2 Energy Efficiency rating of Self-ballasted Lamps

Lamp configuration	**Power Rating (LP watt)**	**Minimum Efficiency (lumen/W)**
Bare lamp	Less than 15; more than or equal to 15	More than or equal to 45 More than or equal to 60
Converted lamps without reflectors	Less than 15; More than or equal to 15 but less than 19 More than or equal to 19 but less than 25; More than or equal to 25	More than or equal to 40 More than or equal to 48 More than or equal to 50 More than or equal to 55
Lamp with reflectors	Less than 20; More than or equal to 20	More than or equal to 33 More than or equal to 40

Source: Energy commission, (2005)

2.12.3 The Energy Efficiency Regulation (LI 1932, 2008)

The follow up regulations after the passage of the efficiency standards and labelling regulation and the successful implementation of the efficiency lighting policy in 2007 and another important regulation or legal framework is the Energy efficiency regulation LI 1932 which was passed in 2008 to prohibit the manufacturing, importation and sale of incandescent filament lamps, used refrigerators, used refrigerators-freezers, used freezers and used Air-conditioners (Energy Commission, 2013). Aside the prohibition of the importation of used and inefficient home appliances into the country, the refrigerator exchange and rebate scheme was also implemented by energy commission to phase out the existing used refrigerators and freezers in homes and in the market to prevent further purchase and use. The focus of this regulation was on refrigerator and freezers out of the total household appliance because a research conducted by UNDP (2014) on refrigerating appliance market in Ghana showed that refrigerating appliances consumed an average of 1140 kWh of electricity annually which is approximately three time more energy than the maximum allowed for countries with robust efficiency standards and labelling programs.

With the use of petroleum products in the country the efficiency and conservation policies to curtail waste and inefficient use was emphasized in the energy sector strategy development plan in which the policy objective is to use market incentives to discourage the importation of high consuming old vehicles (Ministry of Energy, 2010).

2.12.4 Challenges or Barriers to Energy Conservation and Efficiency Policies in Ghana

The overall challenges that the country face in it attempts to address issues of inefficient energy consumption has to do with the challenges of promoting and financing the conservation and efficiency policies (Energy Commission, 2010).

The barriers to the electricity efficiency policy in Ghana range from barriers affecting regulatory institutions, the appliance market and the households or end-users and the causes of these barriers have been identified to be political influence on electricity pricing, import duties on efficient appliances, dispersed appliance markets and the lack of awareness of electricity efficiency and conservation practices (Dramani & Tewari, 2013).

2.13 Conclusion

To conclude this chapter, all the determinants of household energy conservation and efficiency which is reviewed from various researches are all important determinants but it appeared that the various empirical studies had contradicting and inconsistent findings to factors affecting household conservation of energy. The reason may be due to the numerous measures categorization of the independent variables in these Studies and this measure does not explain why the same variable is positive in particular studies and negative in other others.

Another reason why these empirical studies are presenting contradicting finding is because of the fact that they had different sample Size and the time allocated for the studies. There is little investigations on the regional difference in household conservation findings. The issue of time is that, most of the relevant studies have been conducted in the 1970's and there may be a significant change in attitudes and behaviour during this period several research may obtain different finding.

Finally, there has been little empirical studies on the determinants of household energy conservations and efficiency in Ghana. Because most of these studies were conducted in western environment with different people of different way of life and therefore results of this study may differ from the findings of the reviewed studies.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This section of the study presents a brief description of how data was collected, the techniques adopted in eliciting data, the methodology of the study is also briefly explained in this section and also presents a logit regression model on specific energy conservation action as the dependent variable and socio-economic and demographic variables which drives household conservation actions.

3.2 Data

In the collection of data, hundred questionnaires were administered in four different locations namely Ayigya, Amakom, Bomso and Ayeduase in the Kumasi metropolis and 25 households units were selected from each community to elicit relevant information relating to the study. Members of households including household heads above the age of 18 were selected for the purpose of interview. Table 3.1 shows the population and sample size distribution of households in the selected communities.

Table 3.1: Population and Sample size Distribution of Households in selected Communities

Communities	**Population (2000)**	**Population (2010)**	**Projected (2015)**	**Households (2012)**	**Household Size**	**Sample Size (n)**

AYIGYA	30283	39528	202580	5966	5.1	25
AMAKOM	39060	50984	57684	8145	4.8	25
AYEDUASE	7438	9709	10984	1476	5	25
BOMSO	9005	11754	13299	1570	5.7	25
TOTAL	**85786**	**111975**	**284548**	**17157**	**20.6**	**100**

Source: Ghana Statistical Service (2012)

The sample size for each of the community was calculated at a margin of error of 20 using the population of households in each community using the simplified formula for proportions.

$$n = \frac{N}{1 + Ne^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots..1$$

Where n = sample size, N is the total household population and e is the margin of error.

3.3 Econometric Model

The study examines the relationship between household electricity conservation choices and demographic and economic variable like Income of household head, Age, or expenditure on electricity, level of education of respondent and household Characteristics.

This study uses discrete choice or logistic model to estimate household energy conservation behaviour given other private and demographic variables that induces behaviour to either conserve or not to conserve electricity. The choice to use the logistic model is because of the binary nature of the dependent variable which is household conservation behaviour. This method is used to regress a categorical binary variable on one or more independent variables.

Following previous research on household energy conservation (Olsen (1981), Mutua and Kimuyu (2015), Sardianou (2010) and Wang et al (2015)) a logistic model was chosen to examine the factors that influence household electricity conservation given the binary nature of the dependent variable. The following specification was used.

$$CONSERVE = \alpha_0 + a_1 INC + a_2 AGE + \alpha_3 EXELE + \alpha_4 LEVEDU + \alpha_5 HHS + \alpha_6 AWA + \varepsilon \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots 2$$

The independent variables are the socio-economic and demographic variables affecting household specific electricity conservation actions. INC is the monthly income of household head, AGE is the age of household head, EXELE is the monthly expenditure on electricity, LEVEDU is the level of education of household head, HHS is household size measured in terms of the number of people living in the home, AWA is a dummy variable indicating whether household head is aware of energy conservation and efficiency policies and finally ε is the error term capturing all unobserved variables which may affect specific household electricity conservation action.

The dependent variable CONSERVE is a discrete variable which measures the specific household electricity conservation action. The variable represents the odds of household electricity conservation action. The dependent variable is therefore measured in discrete terms in which 1 represent households that have adopted electricity conservation actions and 0 for households that have not adopted electricity conservation actions.

The Statistical package for social sciences (SPSS) were used for the computation of the logistic model estimation and descriptive statistics of various variables observed.

3.4 Subjective Evaluative Analysis

The subjective evaluative approach analysis was used to analyse the response from the respondents in the various communities to ascertain the degree of awareness to the energy conservation and efficient policies in the country and the changing behaviour and appliance use on electricity use. This analysis is based on the researcher's interpretation of the frequencies of various responses. The Yes or No responses from the participants regarding their knowledge on various project and policies on energy conservation and efficiency were examined to establish the degree of awareness among respondents.

3.5 Conclusion

The purpose of this section was to describe the research methodology of this study, explain the sample selection, describe the procedures and instruments used in the collection of data and also provides an explanation of statistical procedures used to analyse the data. This section also gives detailed explanation of the empirical model used in the study with due reference to previous studies which used similar methodology. The logit regression model was chosen because of the binary nature of the dependent variable and the fact that the dependent variable had a dichotomous response which is either to conserve electricity or not to conserve. This is why most previous investigations deemed the logit regression model a suitable approach.

CHAPTER FOUR

DATA ANALYSIS

4.1 Introduction

This chapter analyses and discusses findings of the study from the field. The descriptive analysis of the study is presented which looks at the personal and household characteristics of the study area. Also the empirical results using the binary logistic model are presented and discussed.

4.2 Descriptive statistics

This section provides the descriptive analysis of the study. The descriptive analysis comprises data on income of household head, monthly expenditure of household, knowledge on efficiency standards and others.

Table 4.1: Descriptive Statistics

VARIABLE	N	Minimum	Maximum	Mean	Std. Deviation
CONSERVE	100	.00	1.00	0.78	0.42
INC	100	1.00	4.00	3.0	1.04
EXELE	100	10.00	90.00	32.0	16.54
LEVEDU	100	1.00	4.00	2.0	0.86
AGE	100	1.00	3.00	2.3	0.72
House Number	100	2.00	42.00	11.4	6.47
AWA	100	1.00	2.00	1.5	0.50

Source: Field Survey (2015)

Table 4.1 above gives information on whether respondents have adopted electricity conservation measures or not and also others on monthly income level, monthly expenditure on electricity, education level of the household head, age of the household head, residents number of the household and disclosure on whether respondents are aware of energy efficiency regulations or otherwise. The Table gives the average, minimum, maximum and dispersion around the average statistic of these measures.

The Table shows that out of the 100 respondents to the questionnaires, about 78% indicated having in place electricity conservation measures whiles only 22% had no electricity conservation measures in place. It is a binary variable coded 1 for households having in place electricity conservation measures and 0 for otherwise. The mean of 0.78 implies that most households fall under the odd of adopting electricity conservation measures in the homes.

The monthly income of the household heads were grouped into four. The groups were as follows: GH¢0-240, GH¢250-540, GH¢550-1000 and GH¢1000 and above. The table above shows that most house head have average monthly income corresponding to group 2. Households heads used on average thus earn monthly income in the region of GH¢250-540.

The individual electricity bill levied on heads indicates that on average monthly electricity cost is GH¢31.49 whiles the minimum and maximum cost incurred monthly are GH¢10 and GH¢90 respectively. The educational level of household heads gathered ranged from basic education, senior high school (SHS), University/Tertiary education and post-graduate education. The table above shows that most household heads have up to only SHS education.

The age of the various household heads falls into three categories designed for the purposes of this research. The categories used in respect of age were 18-34 (coded 1), 35-54 (coded 2) and 55 and above (coded 3). The table above reveals that on average household heads used in this research are 35-54 years old.

Household size of respondents was also assessed and the responses show from the table that on average, households in the Kumasi metropolis have 11 residents. The minimum number of residents of a household was 2 and the maximum 42.

Respondents' assessment in terms of their awareness on energy conservation regulations was also made. This is a binary variable coded 1 when respondents have awareness and 2 for otherwise. The statistics on the average shows balanced results suggesting that about half indicated having awareness whiles the other half indicated not having awareness.

4.3 Results of Key Determinants of Electricity Conservation in Ghana (Objective 1: To identify the key determinants of electricity conservation in Kumasi Metropolis)

The research sought to determine the key determinants of electricity conservation behaviour in Ghana. The Table 4.2 presents the regression results on key determinants of electricity conservation in Kumasi Metropolis.

Table 4.2: Regression Results of Key Determinants of Electricity Conservation in Kumasi Metropolis.

Variable							95.0% C.I.for EXP(B)	
	Coefficient	S.E.	Wald	Df	Sig.	Exp(B)	Lower	Upper
INC	-1.021	.322	10.053	1	0.002	.360	.192	.677
AGE	0.450	.409	1.212	1	0.271	1.568	.704	3.495
HHS	-0.058	.041	2.002	1	0.157	.944	.871	1.022
LEVEDU(1)	-0.438	0.28	1.597	3	0.660			
LEVEDU(2)	-0.628	1.478	.181	1	0.671	.533	.029	9.670
LEVEDU(3)	-1.219	1.439	.717	1	0.397	.295	.018	4.962
LEVEDU(4)	-1.057	1.444	.536	1	0.464	.347	.021	5.888
EXELE	.005	.016	.120	1	0.729	1.005	.975	1.037

AWA	1.034	.519	3.968	1	0.046	2.812	1.017	7.778
CONSTANT	1.491	1.867	.638	1	0.424	4.444		

Source: Field Survey (2015)

In finding out the factors accounting for electricity conservation among Ghanaians, economic and demographic factors including monthly income, age, educational level and others were used. The results of the logit empirical model used is shown in Table 4.2.

Monthly income is shown to significantly influence electricity conservation at 1% significance level. The co-efficient shows that a unit change in monthly income leads to a reduction in the logarithm of the odd ratio by 1.021. Put differently, an increase in the income of residents of households by a cedi leads to an increase in the odd ratio by 0.36.

Awareness of efficiency standards and regulations regarding energy conservation also significantly influence electricity conservation behaviour in Ghana. The results show that when individuals become aware of the need to conserve electricity, electricity conservation behaviour increases. The results show that when this level of awareness increases, all other thing being equal, the log of odd ratio increases by 1.034. The odd ratio is the quotient of the probability of conserving electricity and the probability of not conserving electricity. The Table reveals further that the odd ratio increases by 0.046 when the level of awareness goes up meaning that the probability of conserving electricity (numerator) increases.

The results on demographic variable, age is not significant in influencing electricity conservation behaviour in the country. The relationship between age and the probability of electricity conservation is statistically insignificant at all levels of significance, 1, 5 and 10%.

The monthly expenditure incurred by individuals is also not significant in influencing electricity conservation in the country. The number of residents in a house also has no relationship with electricity conservation in the country and lastly, the educational level of individuals is also not significant in influencing electricity conservation.

4.3.1 Diagnostic Statistics

Table 4.3: Hosmer and Lemeshow Test

Step	Chi-square	Df	Sig.
1	4.410	8	0.818

The Hosmer and Lemeshow test is a measure of goodness of fit and shows how well the empirical model used presents the determinants affecting probability of electricity conservation among residents of the Kumasi Metropolis. The null hypothesis of the test indicates that the model has a good-fit. The probability value of the test-statistic shows a value above 5% suggesting that the model has good-fit.

4.3.2 Discussion of Findings on Determinants of Electricity Conservation in Kumasi Metropolis.

The results of the logit regression show that monthly income is significant in influencing electricity conservation behaviour in the Kumasi Metropolis. There is however a negative relationship between income and electricity conservation behaviour. The results suggests that the rich have less electricity conservation behaviour than the poor. This results is contrary to most researches earlier made especially in the advanced countries where it was found that individuals with high income have high propensity to conserve electricity and other alternative forms of energy. This finding was explained away by the fact that the rich use new or brand new electrical appliances compared to the poor who use second-hand appliances with the view of cutting down cost or making cost saving. In Ghana the second-hand refrigerators and other second hand electrical devices which are relatively inefficient are purchased by low income households (Buskirk et al., 2007). Sardianou (2007) proved that household income was largely positively and statistically related to energy conservation. This is because there is a positive relationship between the income allocations to investment in electricity conservation practices.Other researches also lay evidence to the finding in Ghana through this research (Cunningham and Lopreato, 1977; Opinion Research Corporation, 1975c). The finding in Ghana can be explained from the fact that even though brand new electrical appliances are bought by the rich, as a result of their ability to pay the cost of electricity, growing apathy towards electricity conservation sets in and can also be attributed to the impact of the rebound effect. The poor however are conscious of electricity conservation because of its implication on the cost of electricity. The average income of the respondents used for the research fell in the second income group ¢250-540 suggesting that most people falling in the research group do not have high income all other things being equal. Also responses from respondents on their motivation for embarking on electricity conservation behaviour point that most do so to reduce electricity cost.

Age as a demographic variable is not significant in affecting the probability of electricity conservation in Ghana. The results suggests that there is no difference between the young and the old in terms of electricity conservation behaviour. This finding in Ghana can be explained from sociological factors such as norm. This suggests further that electricity conservation behaviour is on average not identified with the Ghanaian and thus the young have nothing to learn from the aged in terms of this. Thus both the young and the old are indifferent in terms of electricity conservation making it thus a non-factor in influencing electricity conservation behaviour. The results in Ghana is contrary to most findings in the literature. Walsh (1989) found that the younger household heads are more likely to make conservation measures than the elderly people. He reiterated that investment in conservation measures is less likely to be made by the older people as they do not expect a significant rate of return from energy improvement as do their other age cohorts. The motivation for instance found by Walsh (1989) is probably not identified with the Ghanaian that some returns are likely to be derived for saving energy as identified with the young. The average age of respondents used in the research fell in 34-54 years which qualifies them to be youth. However the fact that dependency on these is usually high, conserving electricity to probably reduce electricity cost to relieve their burden a bit is not even identified with them. Long (1993) estimations on energy conservation expenditure of Americans in 1981 showed a positive relationship between the age of respondent and the expenditure allocated for investment into energy conservation measures.

The results also show that the number of residents in a household has no significant influence on electricity conservation behaviour. The import of this finding is a house having more people compared to a house having less people have the same electricity conservation behaviour, all other things being equal. This finding in Ghana can be explained also from the "organic nature" of places such as Kumasi used for the research unlike the villages where lives of residents seem to be woven together and as such decisions on electricity conservation can be taken together. Since this is lacking, the results point that household size is insignificant in influencing electricity conservation in Ghana. The positive relationship however agrees with literature though not significant. The insignificance thus contradicts Curtis et al., (1984) finding that occupants have positive relationship with in-home energy consumption.

The level of education ranging from basic, Junior high school, Senior high school, and post-graduate education is also not significant in affecting electricity conservation among residents in the research area. Elsewhere, it has been found that there is a positive connection between level of education and energy conservation behaviour. This finding is explained in the literature in association with the results on positive relationship between income and energy conservation behaviour since high education gives high income, all other things being equal. The inconsequence of differential in education on electricity conservation behaviour can be explained from the sociological perspective that residents have been dominated by their norm in the society where energy conservation is relegated to the background. Thus the highly educated and the less educated behaviour have the same attitude towards conserving electricity and other alternative forms. The finding in Ghana is consistent with the results of Stephanie (2010) where an inconclusive results was found in respect of influence of education on energy conservation practices.

However researches like Leahy & Lyons (2009) concluded level of education has positive relationship with energy conservation and they explained the educated usually own many domestic appliances and hence have the high tendency to conserve energy.

The monthly electricity bill incurred by residents is identified to have positive relationship with electricity conservation behaviour though not significant. The positive relationship agrees with expectations since high electricity cost is expected to engender energy-saving behaviour among residents all other things being equal. Though positive, its insignificance contradict findings established in the literature.Walsh (1989) found a positive relationship between probability of household’s energy conservation improvement and the increase in high prices of fuel after a survey of 2.911 Californian households whiles Pit and Wittenbach (1981) also found the same results of a positive relationship between energy conservation improvement and expected price increase.The insignificance of the cost of electricity in Ghana can be explained from the fact that monthly electricity cost among households on average is small. The average monthly electricity cost among respondents was found to be GH¢3. This is so since most respondents do not live in apartments but live in large compounds with many residents, electricity cost is shared and all other things being equal, individual residents' share of the cost is reduced. The brunt of electricity cost is presumably not felt among households that much and this consequently fails to compel residents to conserve electricity. The results in respect of this probably among businesses or apartment-dominated residents might be different. In the literature some researches also recognize the fact that electricity price hikes do not always motivate conservation activities. Dillman et al (1983) confirmed this in the US when price hikes caused wealthy individuals to increase their conservation practices whiles the poor cut down on their investment in energy conservation.

Awareness of energy conservation regulations is found to significantly influence electricity conservation in the country. This agrees with expectation since the more conscious individuals become in terms of energy conservation practices, the more they are expected to conserve electricity all other things being equal. When individuals understand the need of conserving electricity and the benefits they stand to gain as well as the macro-effect on the economy, the tendency to conserve electricity increases. The results point out that residents who are not knowledgeable of the need to conserve electricity do conserve electricity little. In terms of the impact of information on energy conservation behaviour the literature reveals mixed results. Curtis et al (1984) found that information gains help in cultivating energy conservation behavior among individuals. However Benders et al (2006) posit that the influence on information on energy behavior depends on whether that would not

restrict the lifestyle of the individual or otherwise.

4.4 Results on Awareness of Household on Energy Conservation policies

(Objective 2: To ascertain the Level of Awareness of Households in the Kumasi Metropolis on Energy Conservation Policies and Projects in Ghana)

The research sought to find out the level of awareness of residents in respect of the various households and energy conservation policies in Ghana. Specifically, awareness on energy efficiency standards and labelling regulation (LI 18150), refrigerator exchange scheme and efficient lighting project was sought from respondents. The responses from respondents are tabulated below.

Table 4.3: Results on Awareness of Energy Conservation Policies

Question		Frequency	Mean
Knowledge on efficiency standards	Yes	48	1.5165
	No	52	
Energy labelling standards	Yes	48	1.5165
	No	52	
Understanding of energy conservation	Yes	57	1.3736
	No	43	
Importance of efficiency regulations in reducing electricity bill	Yes	69	1.2418
	No	31	
Knowledge on refrigerator exchange and rebate scheme	Yes	65	1.3407
	No	35	
Beneficiary/non-beneficiary status of the exchange scheme	Yes	21	1.8681
	No	79	

Household's knowledge on efficient lighting project	Yes	72	1.2527
	No	28	

Source: Field Survey (2015)

Table 4.3 shows the responses obtained from residents in respect of their awareness on the energy efficiency standards and labelling regulation in Ghana. The Table shows more respondents indicating their unawareness of the regulation. Specifically, 48 respondents representing 48 % indicated not being aware of the regulation whiles 52 respondents representing 52% indicated being conscious of the regulation. The question coded yes/no as 1 and 2 respectively shows a mean value above 1.5 confirming that more of the respondents were not aware of the regulation. This finding culminates into buyers' responses towards items having energy label or not acquired.

Responses from residents on appliances acquired having energy label or not reveals that more respondents have acquired appliances not having energy label. Specifically, 52 (52%) indicated having bought appliances not having energy label whiles 48 respondents representing 48% had acquired appliances with energy label on them. These figures replicate those derived from the table on knowledge on regulations on energy efficiency and label suggesting that buyers of electrical appliances act to the extent of their knowledge. The results is further corroborated by the mean value above 1.5 meaning that more respondents have bought appliances without looking at the energy label.

The reaction of residents or buyers towards appliances having energy label or not depends on the understanding of what is even meant by energy efficiency standards and labelling. Respondents were assessed in respect of this and table 4.3 reveals information on this. The table reveals a mean value below 1.5. With the question coded 1 and 2 respectively for yes and No on whether a respondent understands energy conservation measures indicates that most respondents have understanding of energy conservation measures.

The responses of residents towards the energy efficiency standards and labelling were also identified to be partly motivated by their thought on the efficacy of the regulation in reducing their electricity bill. The assessment of respondents in respect of this reveals the following results:

The table shows that 69 (69%) respondents indicated that the energy efficiency regulation would help reduce their electricity cost whiles 31 (31%) also intimated that the regulation has no effect on reducing their electricity bill. This is further corroborated by the mean value below 1.5 indicating that with the question coded 1 for Yes and 2 for No, most respondents fall on the side of Yes on a continuum of Yes
(1) and No (2).

The refrigerator/freezer exchange scheme in Ghana was also assessed to know the level of awareness of this among residents. The Table 4.3 reveals that 65 respondents indicated having knowledge of this representing 65% whiles 35 indicated having no knowledge of it. This represents 35%. The extent of knowledge in respect of the exchange scheme assessed was also expected to culminate in the responses of residents towards benefits that can be derived under the scheme. Respondents were thus assessed also on whether they have benefited from the refrigerator exchange scheme or otherwise. Table 4.3 further shows that a mean value above 1.5 in respect of this question meaning that most respondents have not benefitted from the exchange scheme. The contra results shown on the knowledge of residents on the exchange scheme and their reaction can probably be explained by the fact that given the low monthly income of GH¢250-540 of residents, most do not even have second-hand refrigerators to go and exchange them under the scheme. Also probably, respondents have the second hand refrigerators to exchange but the "fear of the unknown" happening such as seizing the second-hand refrigerator without replacement is being avoided.

Assessment of respondents in respect of their knowledge on energy efficient lighting project reveals the above results that 72 respondents indicated having knowledge of the project representing 72% whiles 28 respondents indicated not having knowledge of the project which also represents 28%. The overall view is most people are aware of the efficient lighting project.

The medium of communication through which residents became aware of the various energy policies and regulations was also assessed. The various media assessed were television commercials, radio advertisement, mobile van, and others. The results in respect of the following are shown in the bar chart below:

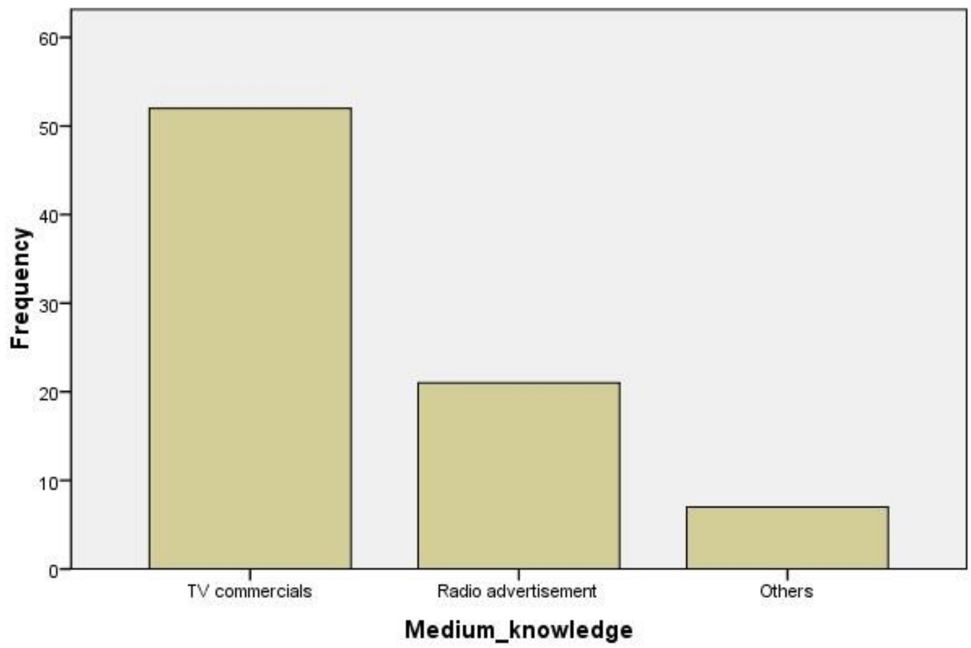


Figure 4.1: Medium of Communicating Energy Conservation Policies.

The bar chart above shows that most respondents had knowledge of the various regulations through TV commercials, followed by radio advertisement and others.

None of the respondents had knowledge of the regulations through the mobile van. Based on the varying responses from respondents in respect of their awareness on the knowledge of energy conservation policies, the following table provides a summary of the three policies.

4.5 Results on Electricity use, Changing Behaviour and Appliance use on Electricity use (objective 3: To examine Electricity use and analyze how Changing Behavior and Appliance use Affects Electricity use in Kumasi Metropolis)

This section examines the electricity use and changing behaviour and appliance use on electricity usage. In achieving this, research sought answers on whether residents use energy efficient appliances, have electricity conservation practices, motivation behind those practices and others. Also, appliance ownership among respondents was also examined and the corresponding hours of usage per day.

The electricity conservation behaviour was examined among residents in respect of whether they use energy efficient bulbs in their home or not. Also, the motivation behind residents' behaviour to conserve electricity was examined after customers indicating whether they conserve energy or otherwise. Table 4.4 below shows the results on that.

Table 4.4: Motivation for electricity conservation and energy bulb usage:

	N	Mean
Motivation for conservation	100	1.66
Energy efficient bulb use	100	1.0471

Valid N (listwise)	100	

Source: Field survey (2015)

In examining the motivation behind residents' behaviour of conserving electricity, residents were asked to specify whether they are motivated by saving electricity for future date (coded 1). Reducing their electricity bill (coded 2) and any other factors (coded 3). The mean value shows that most respondents are motivated to conserve electricity in order to reduce their electricity bill. Also, responses from respondents on whether they use energy efficient bulbs coded 1 if yes and 2, for otherwise shows that most respondents use energy efficient bulbs.

In examining the sources of energy for households in the Kumasi Metropolis, various sources of energy ranging from electricity, LPG, Charcoal and fuel woods were assessed. The table below reveals the results on this.

Table 4.5: Sources of Energy for household's in Kumasi metropolis

SOURCES	Frequency	Percent	Valid Percent	Cumulative Percent
Electricity	86	86	86	86
LPG	5	5	5	91
Charcoal	9	9	9	100.0
Fuelwood	0.0	0.0	0.0	
Total	100.0	100.0	100.0	

Source: Field Survey (2015)

Table 4.5 reveals that 86 households in the research area use electricity for various domestic uses ranging from heating, lighting etc. This represents 86% whiles the second most used energy is charcoal with 9 respondents indicating this. Only 5 persons indicated using LPG whiles fuelwoods is not used by the people of the research area. The results show that people in the cities are dependent on electricity more than fuelwoods and other sources of energy which can be identified in the villages.

In examining the electricity use of residents, activities that are likely to increase the electricity bill were also assessed. Respondents indicated in respect of heating water, lighting the room and using electrical appliances in the room which of them increases electricity bill. The table below shows the results of this assessment.

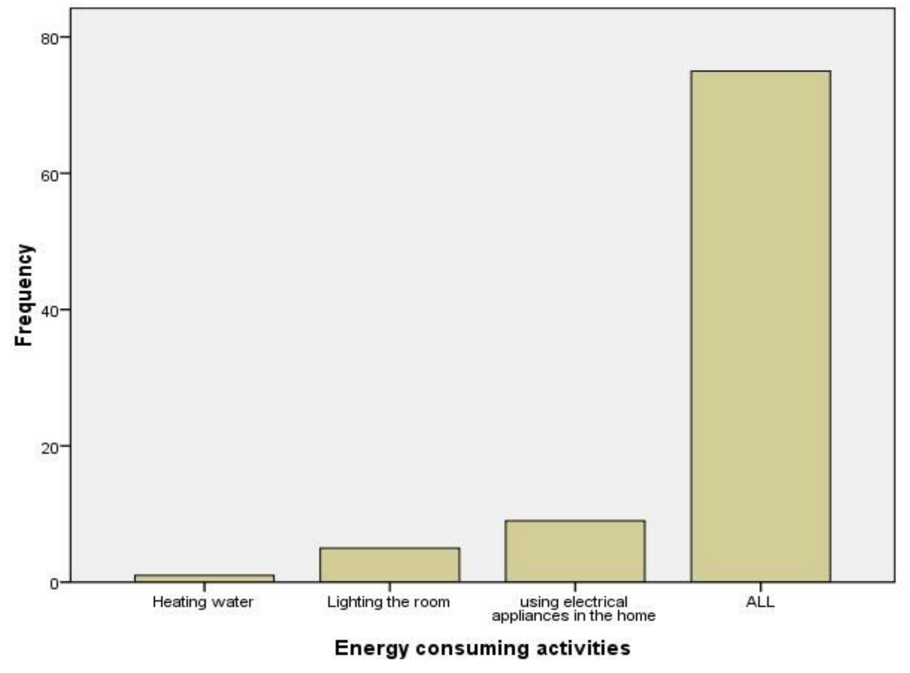


Figure 4.2: Energy Consuming Activities of Respondents

Figure 4.2 shows that heating water, lighting the room and using electrical appliances jointly increase electricity cost. Individually, using electrical appliances adds more to the electricity bill of individuals than lighting the room and just heating water.

Respondents were made to rank the three activities: heating water, lighting the house and using electrical appliance from the most consuming to least consuming in terms of electricity. The results of the ranking show the following:

Table 4.6: Rank of Energy-Consuming Activities:

Activities	Ranking	Mean
Heating Water	2	1.79
Lighting the house	3	2.63
Use of Other Appliances	1	1.55

Source: Field Survey (2015)

Table 4.6 above provides a summary of the rankings made by respondents in terms of heating water, lighting the house and using other appliances on the basis of which is most consuming (coded 1), less consuming (coded 2) and least consuming (coded 3) in terms of energy. From the Table it is seen that, respondents considered using other appliances specified as most consuming (closest to 1), followed by heating water and lastly lighting the house.

The research also found out on the energy conservation behaviour of residents in respect of switching electrical appliances off when not in use, choosing energy efficient products when buying and others, the table below presents the results of the research.

Table 4.7: Electricity Conservation Behaviour/ Activities

Activities	N	Mean
Switching off air condition	100	2.50

Keeping appliances clean	100	2.44
Switching off any appliances	100	2.66
Closing door of refrigerators	100	2.14
Buying energy efficient products	100	2.07
Valid N (listwise)	100	

Source: Field Survey (2015)

Table 4.7 above presents responses from respondents in respect of their energy conservation behaviour on selected activities indicated. Respondents were asked to determine the frequency at which they do each of the activities as to whether the activities are never done (coded 1), sometimes done (coded 2) and always carried out (coded 3). The mean values of the activities show that respondents closely always switch off any appliances which are not in use whiles respondents indicated that they sometimes choose energy efficient products when they are making purchases. Also, respondents sometimes keep appliances clean and also close doors of refrigerators immediately after using them.

As has been identified in the literature, that home appliances used have effect on electricity conservation behaviour and use. The nature of home appliance owned by residents has also been linked with income and education and thus the likely electricity conservation behaviour. A study of household appliance use in Ireland by Leahy and Lyon (2009) in a study of household appliance use in Ireland showed that increase in households' energy consumption in Ireland mainly driven by electricity consumption was attributed to the increase in demand for household appliances between 1994 and 2004.

Accordingly household appliances owned by residents were sought ranging from lights. Electric refrigerator, air conditioner, fan, TV, Electric clothes iron, clothes washer, microwave, radio, stereo and others. The table below provides a summary on appliance ownership and the hours used daily on the appliances.

Table 4.8: Appliance Ownership and Hours used Daily:

	N	Mean
Appliance ownership	100	1.80
Hours per day	100	9.46
Valid N (listwise)	100	

Source: Field Survey (2015)

The mean figure of the appliance ownership suggests that most residents used for the research at least have lights in their room. Most respondents indicated having lights as the common appliance they have with varying information on television sets, refrigerators and others. The mean value of hours used daily suggests that on average resident's use approximately 9 hours out of the 24 hours given on appliances.

Following this residents in their own view were examined whether they are efficient personally in energy usage and their homes. The table 4.9 below provides information on this.

Table 4.9: Energy Efficiency

	N	Mean
Personal energy efficiency	100	2.0
Home energy efficiency	100	4.0

Valid N (listwise)	100	

Source: Field Survey (2015)

Table 4.9 shows that the ratings made by respondents themselves in respect of whether they are personally efficient or their homes are also efficient in electricity usage. Respondents were assessed as to whether they are very efficient (coded 1), quite efficient (coded 2), neither of the two (coded 3), quite inefficient (coded 4) and very inefficient (coded 5). The mean value of the personal efficiency assessment shows that most respondents deem themselves to be quite efficient whiles the mean value of the home efficiency assessment also suggests that most homes deem their energy efficiency as also quite efficient.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter summarises the findings of determinants of electricity conservation among Ghanaians using a case study of selected areas in the Kumasi metropolis. Also, the awareness of the various energy conservation measures in place and the electricity use and influence of appliances usage on electricity use are also summarised. The chapter ends with recommendations hinged on the findings of the research.

5.2 Summary of Findings

The research examined the factors accounting for energy conservation in the Kumasi metropolis and found the following:

Monthly income of residents is significant and negatively related to energy conservation suggesting that people in the low income bracket relatively practise energy conservation more than people in the high income bracket. This negative relationship between monthly income and electricity conservation shows the implication of the rebound effect which arises when electricity consumption increases due to household increasing acquisition of appliance resulting from increase in households income.

The awareness of residents on the need for energy conservation upon examination was found to positively and significantly influential in affecting electricity conservation. The implication is when residents through the various media understand the need for energy conservation, they practise it which in the final analysis changes positively their electricity conservation behaviour.

Demographic variable such as age upon examination was seen to have no significant influence on electricity conservation behaviour among people of the Kumasi Metropolis. The import of this finding is there is no difference between the young and the old in terms of energy conservation which contradicts the literature in the advanced economies.

The level of education ranging from basic education to post-graduate education was also assessed to have no impact on electricity conservation behaviour among people of the Kumasi Metropolis. This suggests that there is no difference between the less literate and the highly literate in terms of electricity conservation.

The electricity expenditure incurred monthly by residents was also found to have no significant influence on electricity conservation behaviour of residents. Possible reason accounting for this could be the fact that electricity cost is shared and individual cost tends to reduce as a result of this making residents not pushed by this to cultivate electricity conservation behaviour.

Household size measured by the number of residents in the house was found also not significant in influencing electricity conservation behaviour. This means that there is no difference between the large and small households in terms of electricity conservation.

The results or the findings thus point that in Kumasi Metropolis two key determinants: monthly income and awareness of the need for energy conservation behaviour affect electricity conservation behaviour.

The research also found that most residents in the metropolis rely on electricity as their source of power as expected from a place such as Kumasi which is a city. Upon examining the knowledge of residents on the various policies on energy including energy efficiency and label regulation, refrigerator exchange scheme and the lighting project, respondents demonstrated more knowledge on the lighting project.

The research also found that though most people indicated being aware of the refrigerator exchange scheme, but not greater percentage had benefited from the scheme.

The electricity conservation behaviour in respect of some daily decisions respondents are confronted with was examined. The research found that respondents on average do not have the behaviour of "always" practising electricity conservation behaviour.

The use of other electrical appliances was also fond from respondents to have greater contribution to electricity bill than heating water and lighting the room.

5.3 Conclusion

The current energy crisis the country is embattled with reinforces the need to have electricity conservation habitually practised by Ghanaians. This research has therefore looked at electricity conservation behaviour in the Kumasi metropolis looking specifically at the determinants of electricity conservation behaviour in the Metropolis. The study used the logistic binary model as a result of the dichotomous nature of the response variable. The study used some selected areas in the Metropolis including Ayigya, Amakom, Ayeduase and Bomso. A sample size of 100 households was carefully chosen after allowing for margin error of 20% using the simplified formula for proportion. The study used questionnaires which were equally distributed among the four communities consisting the sample size. The study found that two key determinants influence electricity conservation behaviour among people of the Kumasi Metropolis: monthly income and the level of awareness on the need for electricity conservation behaviour. Also the findings pointed out that there is no difference between the young and the old in terms of electricity conservation behaviour. The size of a household was also not significant in affecting electricity conservation behaviour. The monthly expenditure incurred on electricity even though most respondents pointed out as the foremost factor that influences their electricity conservation behaviour, was seen not significant in influencing electricity conservation behaviour. Electricty conservation behaviour was seen as not habitual of people of the Metropolis as most respondents indicated engaging in selected electricity conserving activities “sometimes” rather than “always”.

5.4 Recommendations

The research found that household’s monthly income negatively affected electricity conservation and implies that households in the low income bracket were more likely to adopt electricity conservation measures more than the high income households. This was an indication of the rebound effect which increases gross electricity consumption resulting from the increase acquisition of home appliance when household’s income increases. It is therefore suggested that increasing the monthly salaries of workers and improving the general wellbeing of people while educating them on best conservation practices to avoid the rebound effect will be an effective way to ensure electricity conservation among households in the Kumasi Metropolis.

The research also found that the level of Households awareness on the need to conserve electricity positively influence electricity conservation behaviour. It is therefore suggested that increased education and awareness creation on the various energy conservation regulations and programs, ranging from energy efficiency standards and label; refrigerator exchange scheme and the lighting project is embarked on. The right media of conveying awareness such as the television and radio should be used as pointed by respondents as the most dominant media through which they get aware of energy conservation measures.

Education on energy conservation should also emphasise on the need for energy conservation to be habitually practiced among households of the Kumasi Metropolis. As indicated by respondents that they engage in energy conservation activities, education should bring out the need for residents to make conservation of energy part and parcel of their life such that they do it “always” and not “sometimes”.

Thorough education on the refrigerator exchange scheme should be made. Though respondents showed having knowledge, but not greater proportion had benefited from the scheme. Presumably, the low income of most respondents suggests that respondents might still have second-hand refrigerators. The lack of complete insight into the scheme is probably preventing most from availing themselves under the scheme. Education should thus be made to demystify all perceptions surrounding the scheme.

5.5 Limitations and Future Research

The research in looking at the key determinants of electricity conservation focused on only six variables which may not be enough to generate a fitting model. It is therefore recommended that future research should include more variables to find the determinants of electricity conservation in the Metropolis. The study focused on electricity as a major source of energy for households of Kumasi Metropolis and less emphasis was made for other alternative source of energy. It is recommended that future studies with extend the studies to cover other alternative source of energy to identify how key factors affects their conservation.

Also the research used only four communities to represent the Kumasi Metropolis. It is therefore recommended that future research should expand on the communities to know the real determinants of energy conservation behaviour in the Metropolis.

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