FACULTY OF ENGINEERING, SCIENCE AND MEDICINE

AALBORG UNIVERSITY
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A STUDY ON ELECTRICITY END USE SAVING POTENTIALS IN RESIDENTIAL AND COMMERCIAL BUILDINGS IN GHANA

DEPARTMENT OF DEVELOPMENT AND PLANNING

SUSTAINABLE ENERGY PLANNING AND MANAGEMENT

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AALBORG UNIVERSITY
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DISCLAIMER

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Preface

This report is a 10th semester master thesis submitted as a partial fulfillment of a degree programme offered at Aalborg University, Department of development and Planning in summer 2008. The Chicago style of referencing is used in the report where the authors surname followed by the year of publication is referred. In case of more than three authors, the primary author is referred followed by "et al".

Aknowledgement

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This Thesis Work is dedicated to my Father (deceased) and my Mother

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Summary

The modern civilization into which our lives centre depends on a variety of energy sources for its very existence. Energy use is a basic necessity for all human livelihood and development. It can change the way people live and their daily routine of activities. Interestingly, Some 1.6 billion people, almost a third of the world´s population have no access to electricity or to other modern forms of energy supply 80% of these people can be found in rural areas of developing countries especially in Sub Saharan Africa and South Asia

Apart from the issues with global warming and global climate change, there are other environmental issues that we should be concerned with. These include acid rain, resource depletion, environmental degradation and desertification etc. The burning of coal and other fuels containing sulphur by power plants produces sulphur which reacts with water vapour and becomes acid. The acid in the atmosphere may combine with dust or rain water and can have very adverse effects on plants, animals and even human life

There is hardly a place on earth where energy is not getting more expensive. Not only the cost of gasoline, but also the bills for heating oil and electricity are going up. All of us would welcome a solution a real solution to the rising cost of energy. In recent years energy conservation and efficiency have emerge as one of the options for achieving this goal.

Energy end use efficiency makes us less dependent on energy and also saving us cost of electric usage and most importantly protecting the environment. There is no doubt many develop countries have perused this over the years in improving the energy services in various sectors. The *figure 1.2* below shows how countries in OECD have been improving their gross domestic product with necessarily increasing their energy demands.

The study established two key issues with Ghana's electricity consumption. The first is that, Ghana is faced with quantity demand and supply gap, ie insufficient electricity generation capacity to meet nationwide demand. And the second is that the country is comfronted with inefficiencies in both the supply and demand side of electric power generation.

To conclude on the formulated problem, the report showed that there pursuing electricity end use efficiency in the residential and commercial sectors in Ghana holds interesting possibilities of adding to the electricity demands in the country by adding to the grid the saved otherwise would been wasted electricity with no environmental cost to the nation. However, demand side managent can only work to an extent, no matter the levels of demand side measures Ghana pursues, we will still need electric power to operate "our efficient" end user appliance. This means that, demand side management should used and adopted together with other measures to ensure Ghana achieves her goals of becoming a middle income country by 2020.

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CHAPTER ONE

INTRODUCTION, PROBLEM ANALYSES AND METHODOLOGICAL FRAMEWORK

1.1 Introduction

The modern civilization into which our lives centre depends on a variety of energy sources for its very existence. Energy use is a basic necessity for all human livelihood and development. It can change the way people live and their daily routine of activities. Interestingly, Some 1.6 billion people, almost a third of the world´s population have no access to electricity or to other modern forms of energy supply 80% of these people can be found in rural areas of developing countries especially in Sub Saharan Africa and South Asia (Internarionl Energy Agency, 2005).

Every day we depend so much on fossil fuels and other forms of fuel in some way; to cook our food, transport us to work, light, cool, warm our homes, etc. Though we may at times take this for granted, without energy modern life will come to a standstill if not stop completely. No wonder author *Williams H. Kemp* describes energy as *"the life breath of modern society"* (Kemp, 2005). Electricity is a vital ingredient in the socio-economic development of any nation, especially so are developing nations including Ghana. Not only is it critical factor and a "pillar" of development, it is sometimes seen as a measure of the quality and standard of living of a nation *(it must be noted however that, high consumption of electricity does not always reflect high standard of living, it might be a fundamental sign of inefficiencies in the electricity sector).* Without a secured, sustainable, reliable and affordable supply of electric power, Ghana can hardly make any progress in socio-economic development and be able to achieve her 10% - 12% GDP growth target and become a middle income country by 2020 (Amadu and Turkson, 1999).

Current energy usage trends do not indicate any reversal of this dependence of energy resources. In a recent report by Energy Information Administration *(an official energy statistics from the United States Government)* in the International Outlook report for 2007, the world's energy consumption will continue on steady growth up to a projection year of 2030. Total world consumption of marketed energy is projected to increase from $131x10^6$ gigawatt-hour in 2004 $164x10^6$ gigawatt-hour to in 2015 and then to $206x10^6$ gigawatt-hour 2030—a 57-percent

increase over the projection period. Large proportions of such increases will occur in Non Organization for Economic Cooperation and Development *(OECD)* with 95% compared to only 24% in OCED countries over the same projection period (EIA, 2007). This growth in energy demand among the non-OECD countries is largely due to strong projected economic growth. In all the non-OECD regions combined, economic activity—as measured by Gross Domestic Product *(GDP)* in purchasing power parity terms increases by 5.3% per year on average compared with an average of 2.5% per year for the *OECD* economies.

Though the *EIA* projections shows there will be a significant increase in energy consumption in Non OCED countries particularly those in developing countries, the current energy situation in most developing nations especially in Sub Saharan Africa needs much to be desired. It has the geographical size of United States of America, Europe, Australia, Brazil and Japan combined (*approximately 30.3 million km^2)* a total population of 885 million people in 53 countries yet uses only 9%, 17% and 50% of the energy used by in North America, Europe and Latin America respectively (Davidson et al, 2007). For rural sub-Saharan Africa, where the majority of the population lives, the reality is worse.

In recent times however, access to modern forms of energy has improved and increased modestly in sub-Saharan Africa from 17% to 24% as whole in the years 2000–2002 and from 3% to 9% in rural areas (IEA, 2004). Such increases could be attributed to many national initiatives such as the ongoing power sector reform programmes and many nationwide rural electrification programmes. Yet much more needs to be done to improve the region's competitive position compared to other developing regions of the world.

Since fossil fuels will still have a big consumption share *(though as projected by the International Outlook Report, 2007, other sources of energy such as renewable energy will make inroads into this lead),* it presents various challenges in terms of the environmental, economic concerns and security of supply. A former Saudi Arabian minister of oil, Sheikh Zaki Yamani sums the world dependence on fossil fuel particularly oil by saying *"the Stone Age did not end because for lack of stones, and the Oil Age will end before the world runs out of oil"* (Kemp, 2005).

1.2 Environmental Concerns

Since 1987, after the establishment of the World Commission on Environment and Development headed by G.H. Brundland, there is no doubt that the issues concerning the environment especially the issues of ozone and resource depletion and more urgently today climate change have gain more momentum than never before. Today it is a common and a welcome fact that something must be done to reduce if not reverse the CO_2 emissions into the atmosphere. The issue of climate change is one of the key challenges confronting sustainable development. Burning of fossil fuel for energy among other things is mainly seen as one of the biggest causative agents of a warming world. Coupled with the fact that, the world´s consumption of energy from fossil fuel will increase so is the associated CO_2 emissions.

According to International Energy Outlook 2007 by the Energy Information Administration *(an official energy statistics from the United States Government)* scenario analysis, world CO_2 emission will increase from 33.9 billion metric tonnes in 2015 to 42.9 billion metric tonnes in 2030 representing an increment of 59 percent (EIA, 2007). In more recent times, developing and Non OECD countries where more than a third of the world population lack access to modern form of energy has been asking for their fair *share of the energy cake* (Kemp, 2005). EIA outlook report projections predict that lager chunk of energy consumption will occur in developing and other non OECD countries *(especially in Asia).*

Africa contributes only about 3.6% *(see figure 1.1)* of total world energy-related carbon dioxide emissions. So tackling the issues of global climate change has not been the top priority of many African countries. However, there are compelling reasons for global climate change to be taken seriously in the context of Africa. First of all, with expected economic and energy consumption growth come with the related coarbon emmissions to the atmosphere. Also with expected negative impacts from global climate change, Africa needs to take the issues conerning carbon emmissions seriously (IPCC, 2007). Sub-Saharan Africa is home to the world's second largest rain forest, in West Africa. It is one of the world's most important carbon sinks. *(Carbon sinks capture carbon dioxide from the atmosphere).* Thus, there is also another world-wide incentive to be interested in Africa in the context of climate change.

A critical consideration should be given to other activities that can help minimize these adverse effects.

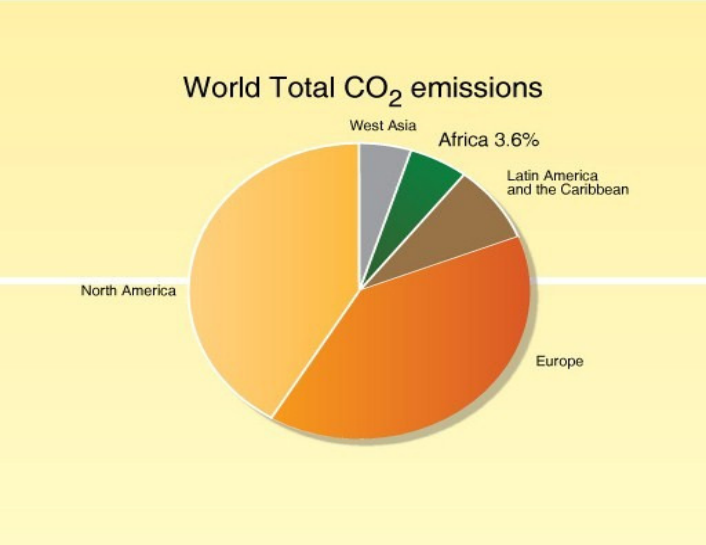

Figure 1.1 showing the proportions of the world´s carbon dioxide emission by region. Source: UN Statistics Division/CDIAC, carbon dioxide emissions per capita, MDG indicator 28 http://unstats.un.org/unsd/mi/mi_series_results.asp?rowId=751 Accessed 10.06.08.

1.3 Other Environmental and Health Concerns

Apart from the issues with global warming and global climate change, there are other environmental issues that we should be concerned with. These include acid rain, resource depletion, environmental degradation and desertification etc. The burning of coal and other fuels containing sulphur by power plants produces sulphur which reacts with water vapour and becomes acid. The acid in the atmosphere may combine with dust or rain water and can have very adverse effects on plants, animals and even human life. Though this has not drawn much attention in recent times like climate, it still poses a great challenge to reduce our energy consumption or fine alternative and cleaner ways of generating them *(note; issues concerning acid rain and its effects drawn huge debates and public demonstrations in the late 70s and early 90s).*

Also, many developing nation over dependence of the forest for their basic energy need (Biomass dependency) means that forest areas are unsustainably used leading to forest

degradation and desertification. According one estimate, sub Sahara Africa depends 90% on biomass for its energy needs compared to the Africa in general which is 60% (Karekeszi, 2002). Increasing use of biomass resources in sub Sahara Africa should increase the awareness of the various environmental and ecological risks if it is not address. Deforestation has negative implications for the local environment which could result in increased erosion, reducing "forest carbon sinks" and threatened biodiversity. According one estimate, if the current rate of deforestation continues many African countries especially Sub Saharan Africa countries could loose as much as 75% of thier forest regions by 2025 (EIA, 2005). Another problem associated with overdependenc on biomass and forest resouces in Africa especiaaly sub Saharan Africa is the health problem. Women and children suffer disproportionately from negative health effect due to the smoke generated in the use of fuelwood for cooking *(smoke is a carcinogen and causes respiratory problems).* About 75% of wood harvested in sub-Saharan Africa is used for household cooking.

Figure 1.2 showing a aparsely forest due to deforestation. Source: EIA, 2007.

Those the favour the building of new power plants to meet the energy demands in Sub Sahara Africa asserts that, building new power plants like the under construction Bui Dam in Ghana, will generate employment and help by injecting capital resources into the economy, create employment and reduce poverty levels in that locality and in the country as whole. Granted, these are the some positive impacts from such projects and are welcomed, however these same people loose sight of the fact that most of these capital investments are foreign donor driven

which come with conditionalities that places more on the rate of returns than on environmental degradation. Of major concern is the scale of environmental impacts from building such large scale hydro dams. Displacement and flooding of large land areas leading to human displacement *(including loss of farm land)* and loss of biodiversity are some of the biggest environmental impacts. The environmental and socio-economic downside of the building of the Akosombo hydro power plant nearly 60 years ago can still be felt and seen today (Hans and Karsten, 2005).

Another major concerns of climate change related impacts are the health issues. Global warming could expand the home range of mosquitos in Africa, and in turn make mosquito-borne malaria an even greater problem than it is today

1.4 Economic Consideration

Since the beginning of 2008 crude oil price reached rocketing levels and has reached never imagined price levels(*www.msnbc.msn.com/id/12400801, accessed 23.04.08*).no one can easily predict the price for a barrel of oil for the next trading day. This extra ordinary price increase has a lot of implications for both dependent developed and developing countries alike. Even the most advanced and affluent economies like the United States of America and in the OCED are feeling the harsh impacts of this high oil prices, not to mention the already unstable and struggling economies of developing countries. Not only do they have to spend large amounts of foreign currencies on oil for energy but also their GDP growth are affected due to the in balances created by high oil prices. For example, Ghana a developing nation net import of crude oil as of 2006 stood at 41700 barrels per day (IEA, 2007). *Figure 1.3* below compares Ghana´s electricity consumption as a per capita with her neighbouring countries and others in the world. This means that, any sharp price increases in the world crude oil price will greatly affect the country in all aspects of her economic activities. Oil which is greatly used in the transport sector in Ghana is also use to a significant degree to generate electricity from two main thermal plants in Takoradi.

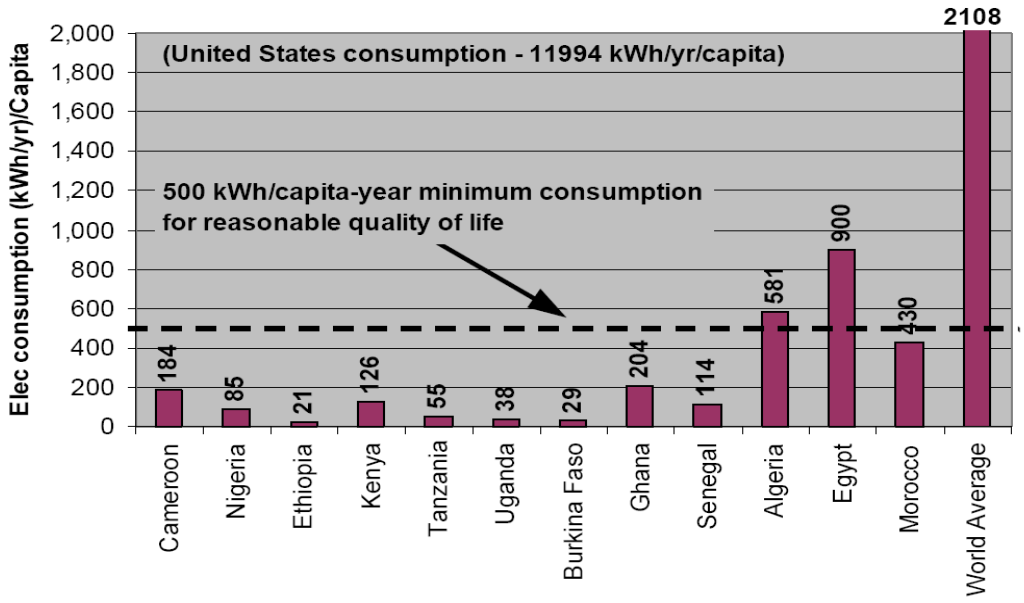

Figure 1.3 showing comparative electricity consumption per capita of some sub Saharan Africa countries and the world average. Source: The World Bank, 2004.

As seen from figure 1.3, most African countries, mostly found in Sub Saharan fall below the world average of 500kWh per capita per year. Countries like Tanzania, Uganda, Ethiopia, Kenya etc have consumption less than 200kWh per capita per year.

Compared to other parts of the world, the African continent has one of the lowest access and consumption to electricity. For example, only 23% of the population in sub Sahara Africa had access to electricity in 2000 compared to 41% in Asia, 87% in Latin America and 91% in the Middle East (Ejigu, 2005). Yet many sub Sahara African countries are faced increasing urbanization (relatively high population increase compared to many developed countries e,g Ghana has a population increase of 2%/annum) and substantial economic and industrial development which will push for more energy and electricity consumption.

These and many other factors *(such as environmental, economic and health issues that come with dependence on unsustainable energy source)* necessitate the search for alternative means of curbing this ever increasing energy needs without necessarily affecting the quality of life or the services they provide.

1.5 The Case for Energy End Use Efficiency

Energy end use efficiency simply put is getting more energy services *(the final output of energy that actually affect quality of life, e.g., using electricity to switch on a television set or playing music)* from same given amount of energy or achieving the same energy services with less amount of energy.

There is hardly a place on earth where energy is not getting more expensive. Not only the cost of gasoline, but also the bills for heating oil and electricity are going up. All of us would welcome a solution a real solution to the rising cost of energy. In recent years energy conservation and efficiency have emerge as one of the options for achieving this goal.

Energy end use efficiency makes us less dependent on energy and also saving us cost of electric usage and most importantly protecting the environment. There is no doubt many develop countries have perused this over the years in improving the energy services in various sectors. The *figure 1.2* below shows how countries in OECD have been improving their gross domestic product with necessarily increasing their energy demands. For instance, total final energy use in OECD countries grew 17% between 1980 and 1998, but the same period the energy intensity *(the ratio of total primary energy supply to GDP)* of economic activity fell by 16%. This shows that CO_2 emissions are possible to decrease without negatively affecting economic growth. In this sense, they confirm the decoupling of economic growth from energy consumption realized in the developed countries and prove that this detachment holds true also for the atmospheric emissions associated with energy use (Liaskas, 2000). A future projected improvement by the International Energy Outlook for 2007 indicates a very promising outlook for 2030. Since mid 70s and early 80s to present there has been focus on the efficiency of most energy uses in homes in the developed countries. Also more introductions of efficient end use electric appliance and better improved houses have led to this (Schipper and Dianne, 1987).

Much of these end use efficiency measures have been concentrated in the developed world where more and more efficient technologies and end use appliances are can be found on the market. As shown in *figure 1.4,* many OCED countries have managed to improve their economic standings without a corresponding increase in energy use. The Danish example of this is illustrated below.

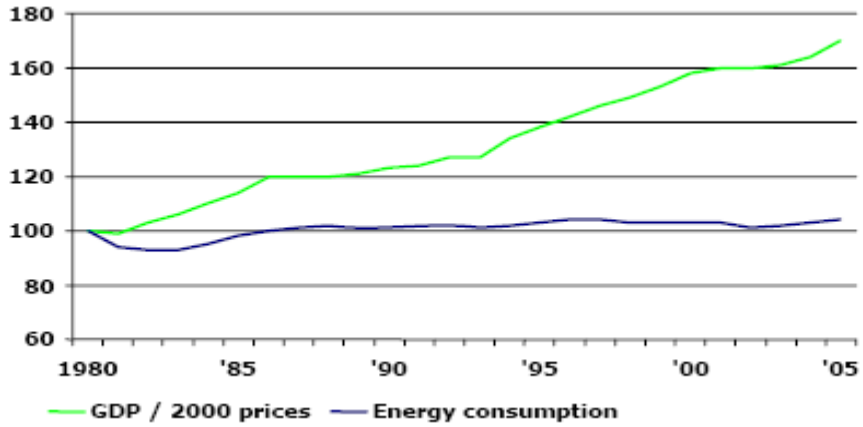

Figure 1.4 showing energy consumption decoupling in Denmark

Energy end use efficiency did not gain much momentum in developing counties *(much of Sub Saharan African countries)* until the beginning of the 90s where foreign donors push for more restructuring in the utility sectors as part of the "conditionalities" for grant assistance (Baiden, 2008). Before this period most utility sectors in the African continent was highly government driven *(that has not change significantly even in modern times)* and was highly subsidised. This led to most utilities not being competitive and at times struggling to meet marginal cost of production. Programmes from the foreign donor agencies especially the World Bank and the International Monetary Fund *(IMF)* initiated changes that will gradually remove government subsidies from utility tariff to ensure competitiveness and promote efficiency both in the supply side and demand side. Whether these programmes achieve their core objective is arguable but for one thing, it set the path to the recognition of the fact that, utilities should used efficiency and tariff prices should reflect cost of production. Since then many African countries have embarked different utility reforms to increase energy production and also conserve and use them more efficiently. There are good reasons for such response.

For example, pursuing energy end use efficiency in electricity sector in Ghana will not only reduce the cost of production for the producing companies and also to the final consumer but help to increase the base of the number of people who can have access to electricity. Therefore it can conveniently be said that, pursuing electricity end use efficiency has a double or even a triple effect. Also energy end use efficiency will be more desired considering the fact that; it does not necessarily result in the reduction in the quality of or a drastic change of life style (Kemp, 2005).

There are many levels of energy efficiency, such as;

a. Upstream end efficiency, the extractive efficiency of converting fuel in the ground (*e.g. coal*) into the primary energy fed into the initial conversion device
b. The technical efficiency along the chain of energy conversions i.e. the conversion efficiency of primary into secondary.
c. The end-use efficiency of converting the delivered secondary energy into such desired energy services as warming food with the micro wave (Lovins, 2005).

This study however focuses on energy end use efficiency mainly with electricity end use efficiency. The primary geographical scope of this study in the developing nation of Ghana but it must be quickly added that various examples are drawn from various countries for emphasis and comparison.

The main objective therefore is;

Objective:
To establish the various improvement potentials to electricity supply and stability through electricity end use efficiency measures in Ghana.

The electricity challenges in Ghana are many and they impact on the overall performance of the country´s social-economic indicators. Poor access to quality health and lack of good educational facilities can be greatly improved with access to modern energy service. Perhaps one of the biggest challenges of promoting electricity end use efficiency in Ghana is could be more ”attitudinal” or “behavioural” *(this conclusion is based on the survey conducted bduring the study period)* as well as other socio-economic challenges such as poverty, illiteracy, etc. The Ghanaian attitude or behaviour towards end use efficiency needs much to be desired. With history of cheap electricity tariff fuelled by cheap power from hydro sources (Amadu and Turkson, 1999), people in Ghana have developed an entrenched behaviour of electricity wasting in the face of dwindling supply. It is not uncommon to find household with several electrical appliance all switched on while they are not been used. The government of Ghana, VRA, ECG,

PURC, EC, EF and other stake holders have embarked on serious campaigns to educate the general public with the view of changing the attitudinal problem. We can expect this programme to have some effects and enhance end user efficiency especially at the residential level. From the informed interview source with ECG, this attitudinal problem is more of residential and commercial than in the industrial sector. Because there are already sanctions in place for any industry who goes beyond the allocated power factor load (Baiden, 2008). Even in the face of tariff adjustment resulting in prices increase, the result of the survey shows that 39 out of 40 Ghanaians surveyed representing approximately 98% said they did not make any changes in their electricity end use consumption at home. This could be an indication that, current tariff prices are still far below the reasonable levels to cause the average consumer make changes in the electricity usage at homes. But we risk neglecting other chanlleges if we narrowly focus on this aspect because maybe behavioural or attitudinal changes is not only triggered by tariff prices increase but rather some combination of issues that shape our social up bringing as Ghanaians. In later part of the report in chapter six, a critical discussion is done on the tariff price increase reforms as a means for promoting end use efficiency in the residential and acommercial sectors.

1.6 Formulation of Problem Study Area and Methodology

As outlined in preceding paragraphs, energy end use has emerged as another focus area not only in saving the environment but also reducing the cost of a nation's or individual energy bill. It also holds the multiple benefits not only to the energy producing companies but also to the final consumer and the environment at the long run. Developing nations *(e.g. Ghana)* with expected expansion in electrification and in industries must have to adopt end use efficiency as part of a diversified solution to her energy shortfalls to reap the needed benefit.

In the wake of recent energy crisis that nearly crippled the Ghana's economy, at one point the main hydro power plant the Akosombo dam was shut down due to inadequate water levels in the dam. The insufficient electricity production led to a serious power rationing where most parts of the country had power in 3days in a week intermittently. This led to severe effect in the industrial sector. It is estimated that, Ghana lost approximately 1% of her GDP due to the energy crisis in 2007. The psychological and physiological and other investment losses cannot even measure. The need for a sustainable and more efficient energy usage has become more urgent than never.

One area that has a promising improvement potential is the end use efficiency of energy in Ghana. According to Ghana's energy commission, in 2005 the sectoral share of electricity consumed by the residential and commercial building sector accounted for nearly 51% (see *figure 1.5, Ghana Energy Commission statistics, and 2006).* The illustrations below show the rising trends of electricity use in the country in the residential and commercial sectors.

	2007	2008	2009	2010	2015	2020	Annual Percentage Increase
ECG							
Accra/Tema	3,083	3,235	3,383	3,569	4,574	5,673	4.80
Kumasi	880	959	1,067	1,134	1,469	1,860	5.93
Other Areas	1,647	1,731	1,794	1,869	2,292	2,801	4.17
Total ECG	5,610	5,925	6,244	6,572	8,335	10,334	4.81
NED	582	618	656	696	916	1,240	5.98
Big Customers	2,842	3,860	4,103	4,487	5,402	6,718	6.84
Exports	1,318	1,318	1,319	1,380	1,383	3,645	8.14
Total VRA	10,352	11,722	12,322	13,136	16,037	21,937	5.95

Table 1.1 showing the demand forecast of electric power up to 2020 by VRA

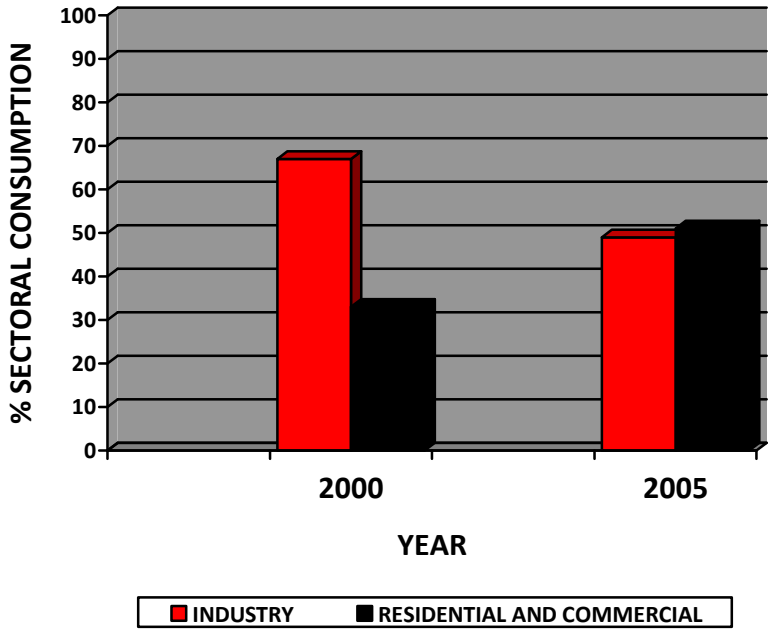

Figure 1.5 Sectoral share of electricity consumption in Ghana 2005. Source: Drawn from Ghana Energy Commission, 2006 data source.

Table 1.1 and *figure 1.5* show that a very substantial quantity of the electricity produced in Ghana is consumed by household and commercial sector *(33% in 2000 rising to 51% in 2005)* in other words in the residential and commercial buildings. Though in figure 1.4 industry appear to have a substantial share of the electricity usage, this study is focusing on the residential and commercial sectors as increasing urbanization and population *(average population growth of 2% and10-15% demand growth due to accelerated urbanization to reach 55% in 2012 and 60% in 2020, ISSER, 2005and Kusi, 2005),* coupled with a government policy of rural electrification will make these sectors one of the big consumption of electricity in few years to come. Again, it appears to regulate and enforce/monitor efficiency measures on the industrial sector where as much more education and focus policy should be adopted if we are to reach the residential electric power users.

A large chunk of the delivered electricity is use for various energy services in this sector. With this knowledge, the question seeking answers is no longer on whether Ghana embarks on electricity end use efficiency but rather how and to what extent electricity end use efficiency can help in achieving a stable and sustaining energy sector in the country.

Table 1.1 gives a projection of ever increasing electricity consumption in the country especially among the three biggest cities in the country namely Accra, Tema and Kumasi. Ghana generates almost 70% (Ghana Energy Commission, 2006) of her electricity from hydro source and with fluctuating rainfall levels over the last decade in the sub region; there is another motivation to embark on electricity end use efficiency in order to fully utilize the little that can be produced. With these considerations among other things, the main research problem of the study is to investigate:

Focal problem:
To what extent can energy end use efficiency in the residential and commercial buildings sectors in Ghana positively contribute to the electricity demands in Ghana and what are the main obstacles in promoting electricity end use efficiency in this sector?

With expected increase in urbanization and population, this report investigates the saving potentials in this area through energy end use efficiency measures and how this can contribute in overall in stabilizing the energy demands in the Ghana. This study will make a careful approach

as to the various means and the improvement potential strategies that could be used in the building sector's end use of energy in Ghana.

This formulated problem will be analyzed using these research questions outlined below:

a. *What is the institutional setup of the electric power sector in Ghana and how have they been performing over the years?*

b. *What are some of the factors that determine future electricity consumption and how should this be integrated into the general electricity end use efficiency policies?*

c. *What is the possible factor of improvement potential in pursuing end use efficiency in the residential and commercial building sector in Ghana?*

d. *What are the various obstacles and challenges in promoting electricity end use efficiency in Ghana and possibilities of overcoming these obstacles and challenges?*

1.7 Research Design

A research design is basically the structure of the report. It links the various aspects of the report together. The choice of methodology and methods with various data collection techniques are explained under the research design.

1.7.1 *The Structure of the report*

The report consists of seven chapters. Each chapter gives a different perspective to the formulated research problem and its related research questions. The flow chart below shows the overall research design of this report.

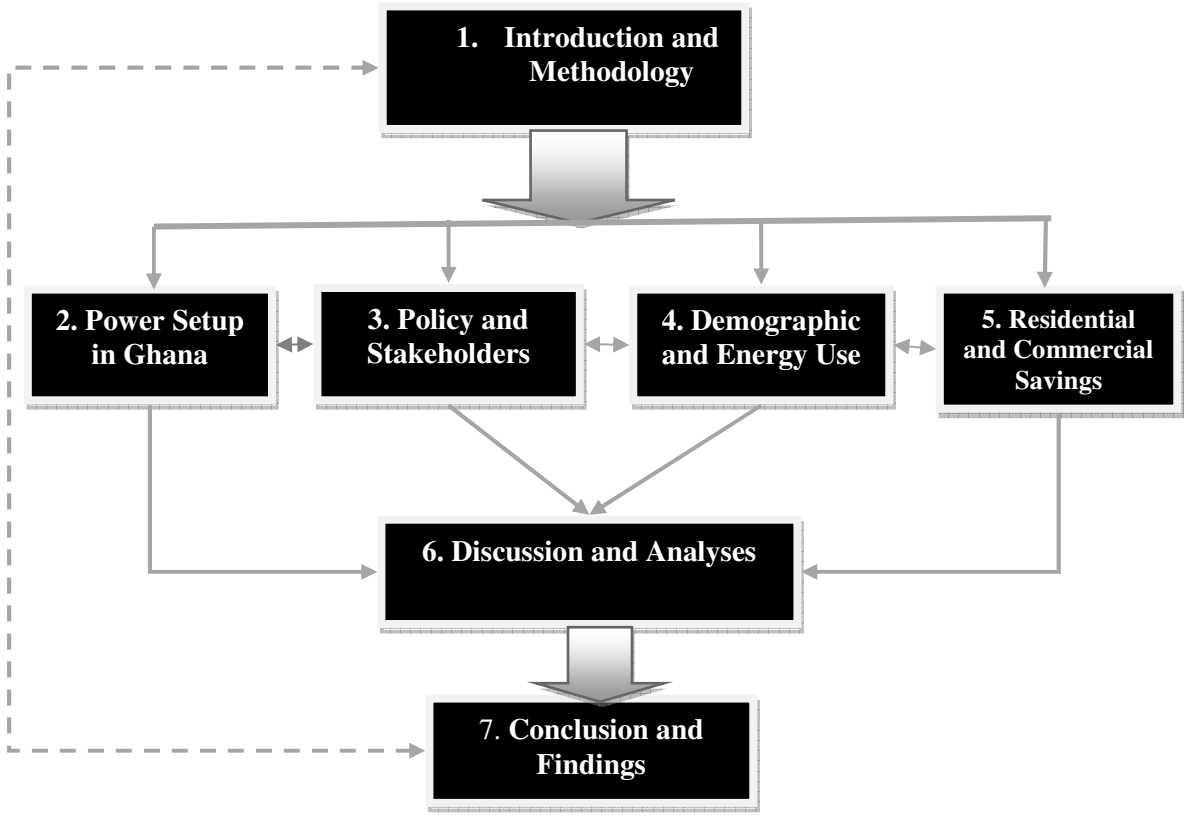

Figure 1. 6, author's illustration of the research structure

1.7.2 Methodology

Research methodology according to Kothari in his book *"Research Methodoligy – methods and techniques* explains research methodology as a "way to systematically solve the research problem" (Kothari, 2005). It comprises the various steps that are adopted in studying the problem. To meaningfully conclude and answer the formulated research problem and its related sub questions in relation to the objective, the study employs both qualitative and quantitative strategies. The qualitative approach is used in describing and presenting the background information of policy, institutions and their functions, the setup of the electric power sector in Ghana and electricity consumption patterns in the country.

The quantitative approach deals with providing the needed numerical data for measuring the extent and degree and rate of occurance for comparison and distinguishing different set of descriptions. They are presented in the study in the form of tables, charts and figures.

However, the main theoretical and conceptual framework under which the qualitative and quantitative approaches are adopted is based on the "top-down" and "bottom-up" conceptual framework. The immediate sub-section explains how and why this conceptual framework is adopted for the study.

The Conceptual Frame Work – "Top-Down and Bottom-Up"

These two concepts or methods involve how a researcher explore for answers to a formulated problem or better still to the unit of analysis.

It is used in many contexts and though its meaning remains same, how it is used may differ a bit based on the context. A "top-down" approach which quite common among researchers involves analyzing the big picture. Some major characteristics of this approach are the macroeconomic approach, looking at the aggregate and also factors that may not be immediately measured. (Wilson and Swisher, 1993). This usually seen in a hierarchical decision making and approaches from that end in solving a problem. For example how a government can regulate a countries energy sector through policies such as tax regulations which will eventually impact on the utility services or the final user to engage in energy efficiency measures. Thus the whole focus is on how these institutions should or ought to function i.e. *regulative* (Scott, 2001) to yield the needed benefits the final consumer. So using a "*top-down"* approach, a problem is considered as one "*mass"* and various aspects of the problems is broken down to the very smallest *unit* to find a solution.

A *"bottom-up"* approach however the individual solutions to a problem are first specified in great detail. These individual solutions are then linked together to form larger sub solutions, which then in turn are linked, sometimes in many levels, until a complete top-level solution is formed. This method often resembles a *"seed"* model, whereby the beginnings are small, but eventually grow in complexity and completeness (Gadomski et al, 1998). This method overlooks the big mass of a solution but rather the focuses on *units* of solutions and how these can be aggregated to achieve a bigger solution. For example, in finding the right policy framework that will guide a nations energy efficiency policies, policy formulation process may start from individual electricity users, individual industries could be analysed and the findings could be use to draft a general policy for the whole country. This approach draws more on public participation

and makes the final consumer more willing and eager to contribute and embrace any policy formulated at the top level or by Government.

There are two key entities in quest for end use electricity efficiency promotion. These are the power generators *(greatly under the influence of the national government)* one hand and the very end user of the electricy *(in residential and commercial sectors, for the purpose of delimitation of this report).* Each entity on the two ends of the scale plays a unique and different role in electricity end use efficiency promotion and are governed and motivated by different objectives. For the generators through the national government wants to maximise marginal cost of production and stay compective while providing quality and efficient services and to the end user maximising marginal utility at the least possible marginal cost.

Therefore, the "top-down" concept seek to unraveal the underlining goals of promoting electricity end use efficiency with policy formulation and the implementation from the perspective of the national government through its agencies such as the Ministry of Energy, Energy Commission, etc. Whereas the "bottom-up" looks at the same objective of end use efficiency promotion from the perspertive of the final individual, household and commercial consumers.

One key advantage of using this methodology is that, the "top-down" and "bottom-up" approach compliment each other and there is less risk of ignoring the issues important to one set of the actors (*policy makers and consumers*). It has a disadvantage of overlooking minor issues that maybe deemed negligible by focusing on the biggers and visible ones.

Figure 1.7 illustrates the different perspective the bottom up and top down methodology approach and solves a problem.

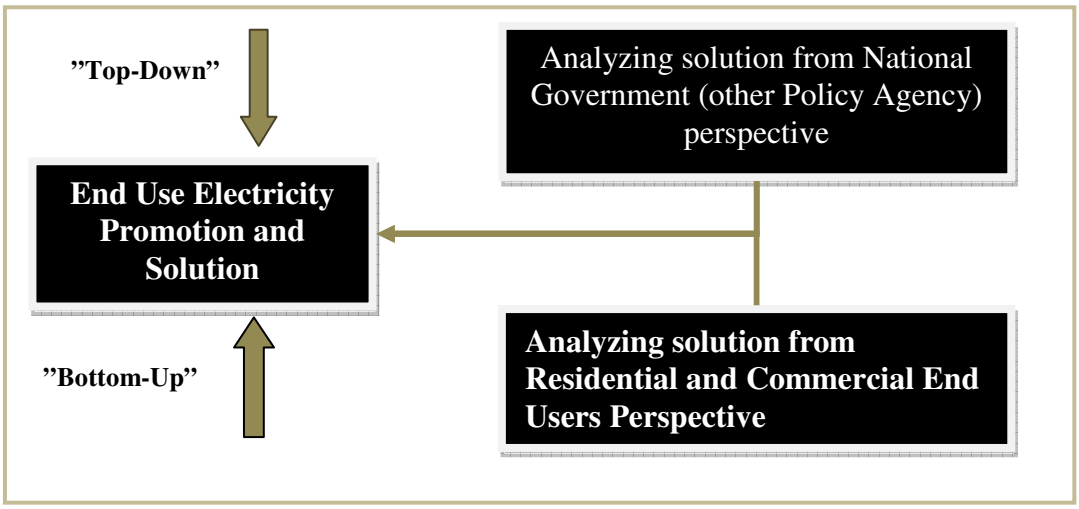

Figure 1.7 illustrating the "top-down" and "bottom-up" conceptual framework

Successfully embarking and promoting electricity end use efficiency will involve not of the final consumers *(demand side)* but also the generators of the energy *(supply side)* and finally the policy makers *(the regulators).* It is interesting to note that, pursuing end use efficiency has positive benefits for all these actors and most important the environment as a whole. This multiple effects of end use efficiency are illustrated in figure 1.8 below. Therefore, analysing the extent of end use efficiency promotion in Ghana using a *"top-down"* and *"bottom-up"* methods will reveal what must be done from the perspective of the policy makers (*"top-down"*) and final consumers (*"bottom-up"*).

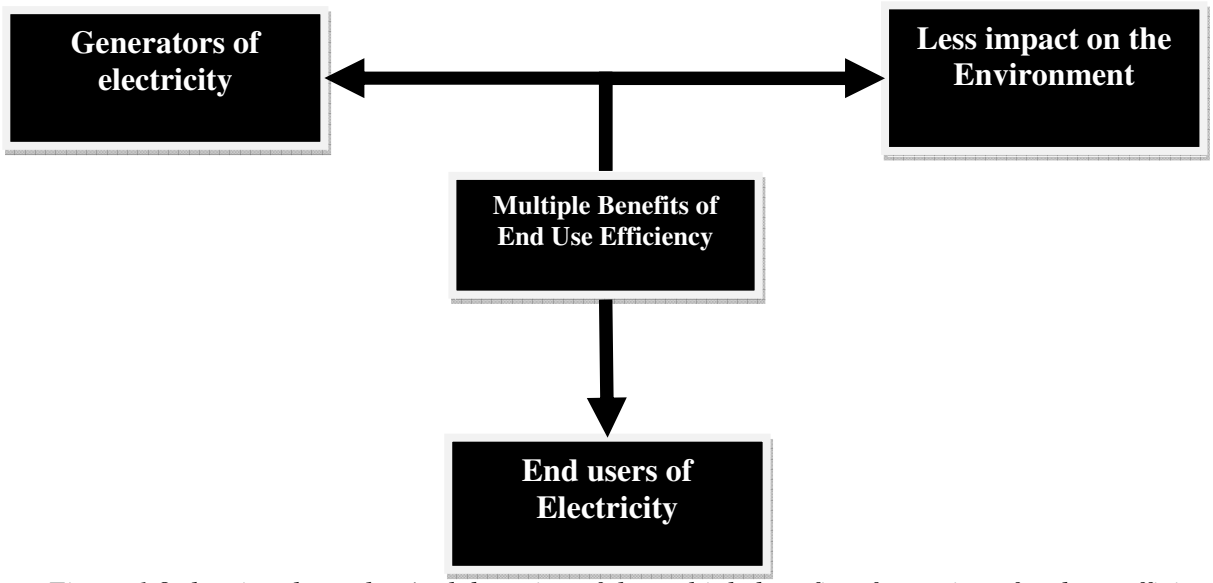

Figure 1.8 showing the author´s elaboration of the multiple benefits of pursuing of end use efficiency

1.7.3 Methods

Research methods are the techniques and ways that are used for conducting the research. Important among these are the data collection techniques and ways for presenting and verifying the validity of the data collected (Kothari, 2005). In selecting the various data collection techniques, Robert Yin points to some important factors that should be considerd first. Any selected technique(s) should be influenced by the nature of the problem questions and its related research questions. The framing of the question starting with "who, what, where, how, and why" will influence the nature of the techniques to deploy to answer them. And "what and who" type of questions can adopt surveys, archival analysis, literature and historical studies and review (Yin, 2003).

Since our research problem and related research questions are of "what" type, the report used the following as the main data collection techniques:

- Literature review and analysis
- Interviews and Questionnaires
- Surveys and Observation

Each and every data collection technique used is further explained below.

Literature: These reports in most of its chapters rely on background literature and information. Varied literature sources were conducted including published books, reviewed scientific writings from know journal data base such as the "science direct", "scopus" were used. Also background literature was sourced from the official internet web sites of organisations, firms and institutions that were under discussion. For example, the Ministry of Energy in Ghana, Energy Commission of Ghana, Volta River Authority, Danish Energy Agency official web sites were consulted for literature. Where data from different sources conflict on the same issue, other data collection techniques were used for verification or in the absence of this, the official web site information of the organisation and institution under discussion takes precedent.

Interviews: this was one of the main sources of quantitative data for the report. Scheduled interviews were arranged with key stakeholders. Interviwees were carefully selected based on their knowledge and experience in the field under discussion and familiarity of the current issues. Interviwees were contacted in advance with predetermined questions by the author. These questions were to serve as the basis for the whole interview. The nature of the interview

conducted can be described as semi-structed one because the set of questions were to serve as quided questions and interviwees were allowed to express their opinion without frequent interruption by the interviwer. This allowed greater intreraction since openly expressing their professional (*and at times personal)* opinions about the issues; it revealed new ideas that the author did not first consider them. The author conducted the interviews through phone and with the permission of the interviwee the interview was recoreded for later transcription. Please see the appendix for all the full transcripts of phone interview conducted.

The table below shows a summary of the interview conducted and questionnairs sent our and the response.

Institution	**Contact**	**Interview/Questionnaire**	**Response**
Electricity Company of Ghana	Mr Baiden	Phone interview	Yes
Volta River Authority - Ghana	Mr O. Opoku	Questionnaire	Yes
Puclic Utility Regulation Commission of Ghana	Mr Robert Segu	Questionnaire	Yes
Energy Foundation of Ghana	Mr Doudu and S. Addo	Had a limited phone interview but due some circumstance could not record and therefore transcript	Partly Yes
Ministry of Energy of Ghana		Questionnaire	No Response
Energy Commission of Ghana	Mr M. Dzobo	Questionnaire	No response
OVE – Denmark	Mr Olesen B. Gunnar	Phone Interview	Yes
Kumasi Institute of Technology and Environment (KITE) – Ghana	Mr Frank A. Owusu	Questionnaire	No response

Table 1.2 showing a summary of the interview conduted during the study period

From the summary table above, it can be said that the overall response rate was good though there were disappointing moments where interviwees had be reminded time and time again thougth E-mails and phone calls and countless rescheduling of interview times and date.

Surveys and Observation: during the study period, the author conducted a survey with some residential end users of electricity to ascertain their views and perspective on the importance of

promoting end use efficiency in the electricity sector. The there were two groups of people surveyed each each group numbering 20, i.e means the survey covered 40 people in all. The respondents for the survey were selected randomly to reflect as varied opinions as possible. The author used specific predetermined set of questions and with some predetermined answers which respondents were expected to choose from. The response rate was very successful as all 40 people contacted accepted to be surveyed. The full results discussion and survey questionnaire are found in chapters 6 and appendix of this report respectively. It muist be pointed out that, in as much the results of the survey may not be taken as conclusive (*due to the number and regional inbalance,* they serve as indicative and provide vital quantitative data for comparison and analysis in this report.

Duing the study period, the author had the previledge of travelling to the study focus country (*Ghana)* and observed and hear some imformal opinions and was updated with some local knowledge. This is vital because it served as guide in deciding which factors truely or will reflect on the people of the country.

None of the above mentioned data collection methods is used in isolation the report but compliment each other and the report draws on all of them throughout the report whenever and wherever necessary. Now that we have set out problem formulation the methodological strategy, let us turn our attention to the rest of the report which focuses on describing, discussing and analysing for solutions, recommendations to the focal formulated problem and the various research questions of the study. *Chapter 2* next sets the background for the historical record of electric power generation in Ghana and the present installed and generation capacities of electrical power in the country.

CHAPTER TWO

ELECTRIC POWER SECTOR SETUP AND BACKGROUD

Purpose: *This chapter explains the setup and the structure of the main institutions in the electricity sector of Ghana particularly those that deal with generation, transmission, distribution and regulatory & monitoring of electricity and tariff setting. Therefore this chapter descriptively outlines the main organizations on three main levels. They include the generation/transmission, distribution and the regulatory/monitoring. Brief histories of these organizations, how they function, operate, and the legislature enacting their operations will also be described.*

2.1 History of Electrical Power Generation

The history of electricity production in modern Ghana dates back during the colonial times in 1914 when the electricity supply sponsored by the government was initiated in Sekondi in the Western part of modern Ghana (ISSER, 2005 and ECG). Since then various reforms and restructuring has taken place. However, it is not the focus of this section of the report to relate the long history and the various transition reforms that took place (i.e. pre independence era). However the historical path of Ghana's electrical power production can be divided into three main phases. **a)** "*Before the hydro years*", this period refers to the time period before the main hydro plant in Akosombo was built in the 1966. **b)** *"The hydro years",* refers to the time period from 1966 when the Akosombo hydro plant was completed to the 80s **c)** *"thermal complementation years",* the 90s to present when thermal plants were used to supplement the hydro generation (ISSER, 2005). This chapter focuses on the post independence era especially since the late 70s to the present time.

With this in mind, it will be difficult to discuss the electric power production during this time frame without it being dominated by the hydro electric power production.

2.1.1 Hydro Generation

Currently, Ghana operates two main hydro power plants and two thermal plants. The first and the biggest hydro plant to be built is the Akosombo hydro plant with an installed capacity of 1020 MW located in the Eastern part of the country in 1966 and the main purpose initially was to supply electric power to the aluminium industry (Zakhary, 1997). The building of the Akosombo

hydro dam flooded the Volta river basin creating the largest manmade lake in the world which covers approximately 3.6% of Ghana's land area (Fobil, 2003). The power generated from the Akosombo plant serves as the driving force behind Ghana's economic development and also supported neighbouring countries such as Togo and Benin by exporting power to these countries (Suave, 2002). With Ghana's expanding industry and economic development caused greater demand for electric power, so in 1982, a second but smaller hydro power plant called the Kpong Hydro plant with an installed capacity of 160 MW was developed on the downstream of the same Volta River to supplement the Akosombo hydro plant (VRA, Ghana). Between 1982 and 1984 occurred one of the most severe droughts in the Volta River Basin in recorded history (ISSER, 2005). This greatly affected the production output of the two hydro electric power plants and led to the search and additional sources of producing electricity other than hydro source.

2.1.2 Thermal Addition

To complement the existing hydro power plants, the Volta River Authority (VRA) in 1997 imitated the Takoradi Thermal Power Station (TPPS) in the Western region of the country, the first of its kind in Ghana. A 550 MW installed capacity with a joint private partnership as part of the government plans to allow private participation in the electricity generation sector. The Takoradi thermal Power Company consist of two companies all located in the same region. It consists of a 330 MW combined cycle plant called Takoradi Thermal Power Company (TAPCO) with a private partnership with CMS Energy of USA in a ratio of 90% (VRA) to 10% (CMS Energy, USA). And the second part is the Takoradi international company (TICO), A 220 MW installed gas turbine plants in a ratio of 10% (VRA) to 90% (CMS Energy, USA). Currently, all the thermal power plants are fuelled with light fuel. However with expected natural gas from Nigeria (as Ghana is part of a West African joint project called the West African Gas Pipe line project) high cost of fuel associated with the light fuel is expected to fall as natural gas is relatively cheaper than light fuel.There is also a 30 MW diesel power plant at Tema near the capital in the Greater Accra region of the country.

Advance plans are under way to develop a third hydro power plant called the Bui Dam with expected installed capacity of approximately 400 MW. Unlike the two other hydro plants, the Bui Dam is a joint venture between the Government of Ghana (GoG) and a Chinese construction company Sino Hydro.

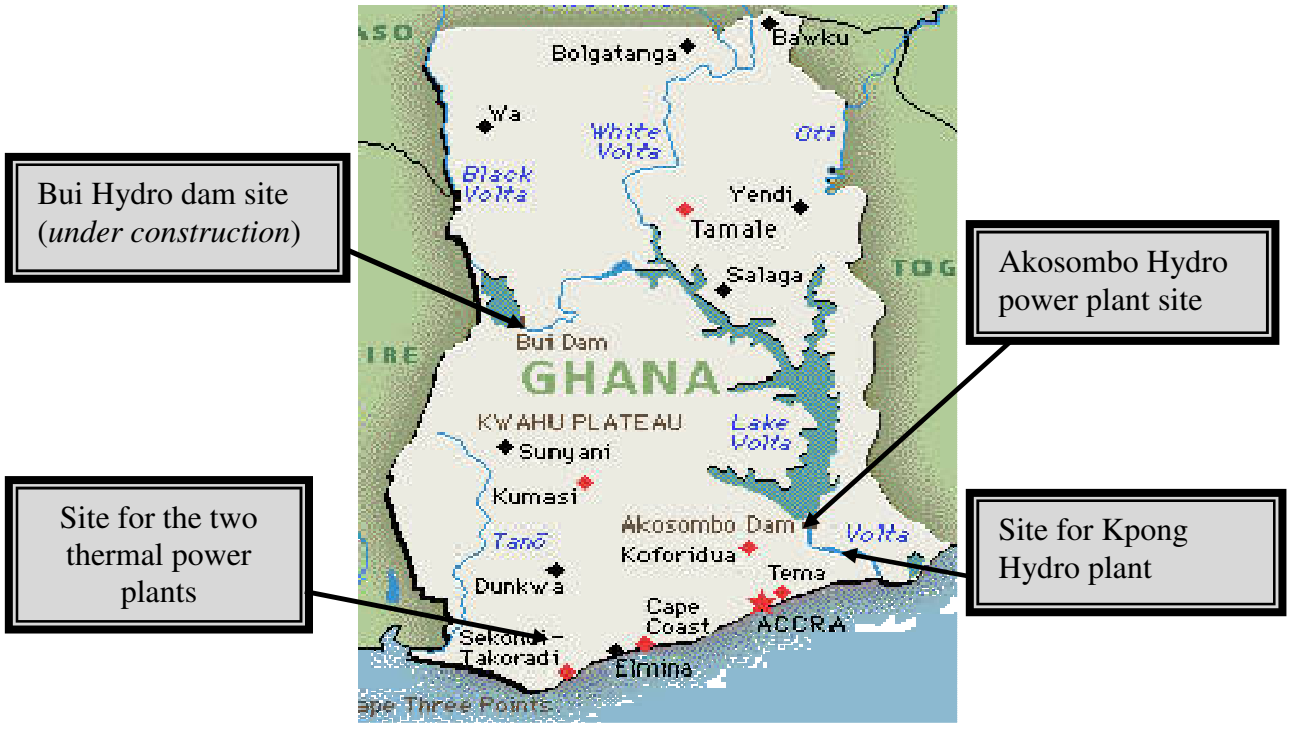

Figure 2.1, Map of Ghana showing sites of hydro and thermal power plants. Map source: greenwichmeantime.com (accessed 25.05.08)

2.2 Electricity Usage in Ghana – Facts and Figures

Ghana generates electricity basically from two main sources being hydro and thermal source. According to data gathered from the Energy commission of Ghana and the Volta River Authority the share of electric power generation from these to source stood at 68% of hydro and 32% of thermal as of 2005 compared to 65% and 35% respectively in 2000. With nearly 1.6 million customers base (Ghana Energy Commission Statistics, 2007); about 54% *(of which approximately 17% are found in rural areas of Ghana compared to the west African sub regional average of 9% rural penetration and access – Wilson, 2004)* of Ghanaians have access to electricity (Baiden, 2008).Therefore, majority of these people can be found in the cities and the regional capitals across the country. The total electricity consumption as of 2005 *(from ECG and NED sales)* stood at 4127 GWh (Ghana Energy Commission, 2007). Out of this nearly 50% *(see Appendix C)* was used by the private sector, i.e. residential and commercial sectors and the rest for industries. The rural penetration of electricity consumption in Ghana vary greatly with

the rural communities along the coast having the highest penetration of 27% followed by those along the forest belt regions with 19% with the least being the savannah regions in the northern part of Ghana with around 5% penetration. Since the 1980s various governmental policies and programs have been geared towards rural electrification. The idea was to boost these rural economies by creating employment and also to help curb the influx and acceleration of rural – urban migration. The annual electricity demand growth is approximately between 10 – 15% (ISSER, 2005). The following tables and figures below show the installed generation electric power capacities, the generation mix of hydro power and thermal, electricity consumption and electricity distribution among different end users. For these tables and figures, unless otherwise stated they are taken directly or modified from the Ghana Energy Commission Statistics for 2007.

NAME OF PLANT	2000	Share (%)	2005	Share (%)
Total Hydro	**1,072**	**65**	**1,180**	**68**
Akosombo Hydro	*912*	*55*	*1020*	*59*
Kpong Hydro	*160*	*10*	*160*	*9*
Total Thermal	**580**	**35**	**550**	**32**
TAPCO	*330*	*20*	*330*	*19*
TICO	*220*	*13*	*220*	*13*
Tema Diesel	*30*	*2*	*0*	*0*
TOTAL	**1,652**		**1,730**	

Table 2.1 a comparative illustration of Ghana´s installed generation capacity (MW) of electric power for 2000 and 2005.

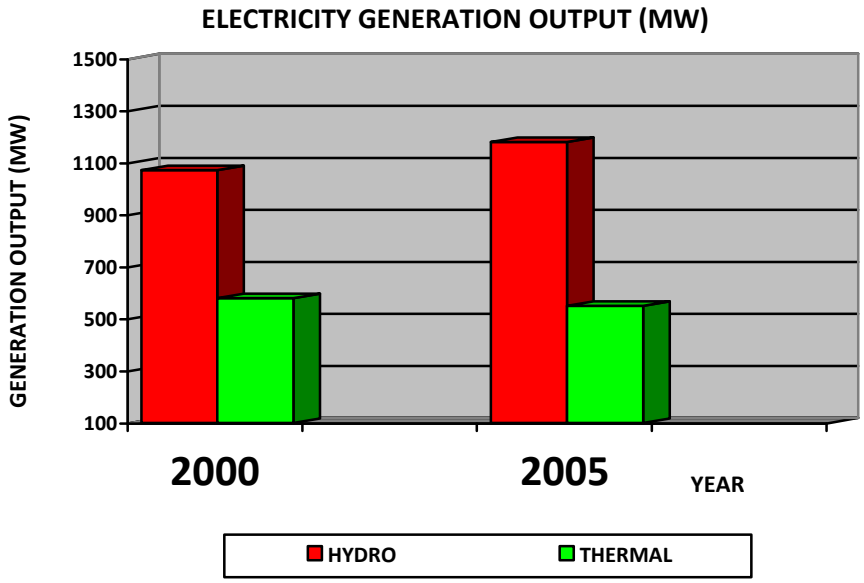

Figure 2.2 showing the generation mix capacity of Ghana for 2000 and 2005. Source: authors illustration based on table 2.1.

From table 2.1 and figure 2.2, it can be seen that, the proportion of electric power generation has relatively remain unchanged since 2000. However this trend is expected to change as more and more Independent Power Producers (IPP) have been attracted to start generating electric power especially since later parts of 2007. As of now, there have been finalized agreements with six of such companies by the Government of Ghana (Baiden, 2008). The electricity crisis of 2007 somehow facilitated the process to allow more independent producers into the generation of electric power in Ghana; however some of these power producers are yet to start actual generation. With the Bui dam *(see figure 2.1),* already under construction, power generation from hydro source is also expected to increase with the Bui hydro power plant adding around 200/400MW.

However, some experts have raised concerns about continual development of centralized large hydro power plants in the face of increasing threats of flooding and prolong droughts. The generation of hydro electric power is very sensitive to unstable precipitation levels due to global climate changes and other local effects (Mwandosya, 2006 and Philip, 2007). As mentioned in Chapter already, the bitter lesions from the electricity crisis in Ghana during the past year

because of inadequate water levels in the Akosombo hydro plant should guide any planning for any future hydro plant installation. Another concern is the fact that, the Bui hydro plant will be situated on the one of the tributaries of the Volta River (*see figure 2.1)* which supplies water for the Akosombo and Kpong hydro plants. So the question is, will there be enough water flow during the construction of the Bui dam and in cases of prolongs droughts as happened in last year.

One notable feature of *the electric supply sector in Ghana* is the high level of distribution losses *(see tables in Appendix C).* Distribution losses average 26% of purchases from VRA compared to 11% to an industry standard of 11% for similar distribution systems (ADF, 2007). Some possible explanation to these high distribution losses may be due to technical issues *(such as poorly maintained overloaded network)* or commercial reasons *(such as defective metering and fraud).*These internal inefficiencies of the distribution utilities could be passed on to end users as part of the production cost hence increasing the marginal cost for consumers *(reducing marginal utility of end users).* Addressing such inefficiency could enhance efforts to promote end use efficiency by giving the distribution utilities a competitive standing in promoting end use efficiency.

Table 2.2 below shows a summary of the two main distribution companies in Ghana, Electricity Company of Ghana *(ECG)* and the Northern Electricity Department *(NED)* customer and sales profile for 2000 – 2005. The table shows an increase in customer base of more than 63% from just over 900,000 to 1,500,000 over the same period, with the biggest increase in the residential and commercial customers. There is a similar increase in the sales of electric power from a total of 3974GWh distributed in 2000 to over 5000GWh in 2005 representing approximately 31% increment.

This growth in customer base *(more households are connected to the grid)* in the residential and commercial sector could be attributed to a lot of factors. Among them is the government nationwide policy of embarking on electrification projects especially in the non urban areas of the country since the late 90s. Also, the country has experienced a significant improvement in her democracy paving the way for a steady economic growth which has resulted improved standards of living. This in turn has triggered increasing demand of basic necessities including

connection to grid electricity. Last but not the least, there is a large influx of people from the rural to urban areas of the country and this has increase the electric power demands especially in the urban regions of the country.

	2000		2003		2005	
	Customer Population	**Energy Sales GWh)**	**Customer Population**	**Energy Sales GWh)**	**Customer Population**	**Energy Sales GWh)**
Residential/Non- Residential	931,803	2005	1,245,085	2325	1,523,389	2,673
Highvoltage >33kv	22	395	23	507	29	431
Mediumvoltage 11 - 33kv	126	437	144	485	174	586
Low Voltage ≤ 1kv	647	305	713	318	761	511
Total	**932746**	**3974**	**1246132**	**4628**	**1524556**	**5218**

Table 2.2 showing a summary of ECG and NED distribution with electric power sales and customer profile. Source; authors compilation from Energy Commission statistics 2007.

A closer look at the electricity available for individuals with access to grid electricity distributed shows a slight fall of electricity per person. The calculation the electricity per person in the residential and commercial sector from table 2.2 was as follows;

{Electricity sales (GWh) * 1,000,000}/ {(customer population*7(*average number of people in a household*)};

For:

2000

(2,005*1,000,000)/(931,803)
= 266.9kWh/person

2005

(2,673*1,000,000)/(1,523,389)
= 250.7kWh/person

These results show that, whereas the residential and commercial customer base has increase significantly, the actual electricity supplied to each individual members of the household has fallen slightly.

2.3 Electric Power Setup in Ghana

The electricity sector setup in Ghana can be group under three headings, namely the generation/transmission, the distribution and regulatory/monitoring. Within this three levels, there are several key organizations involve in the production, distributing, setting up tariffs for

consumers and monitoring the activities of the utilities ensuring that they meet the required standards and operate within the laid down regulations.

The rest of this chapter will be devoted in discussing the major players in the three levels. It must be noted that, this discussion is not a stakeholder analysis in the electricity or in the energy sector will be discussed under subsequent chapters. *Figures 2.3 and 2.4* below illustrate the three levels of components in the electricity sector and organizations in these three levels.

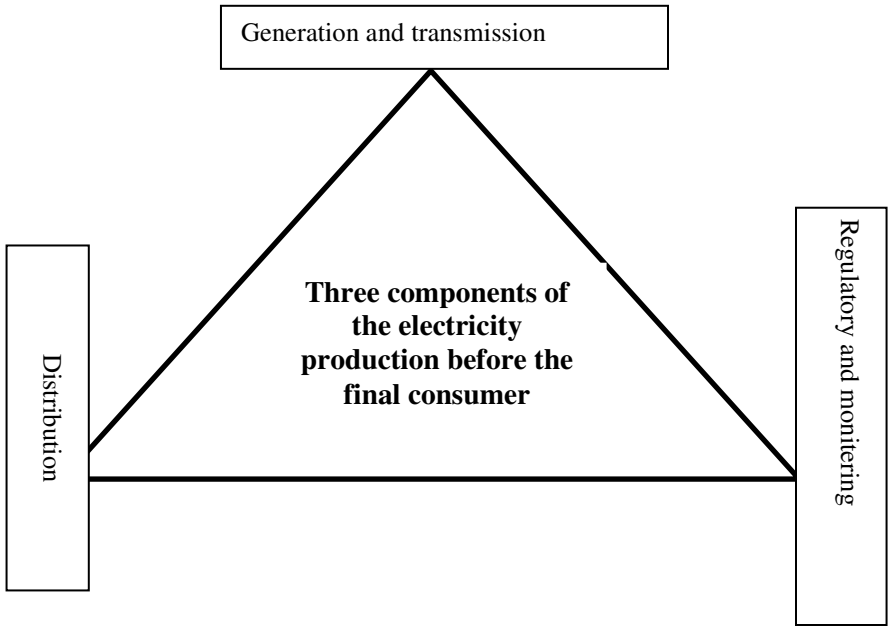

Figure 2.3 authors illustration of the components of the electricity production before it reaches final consumer

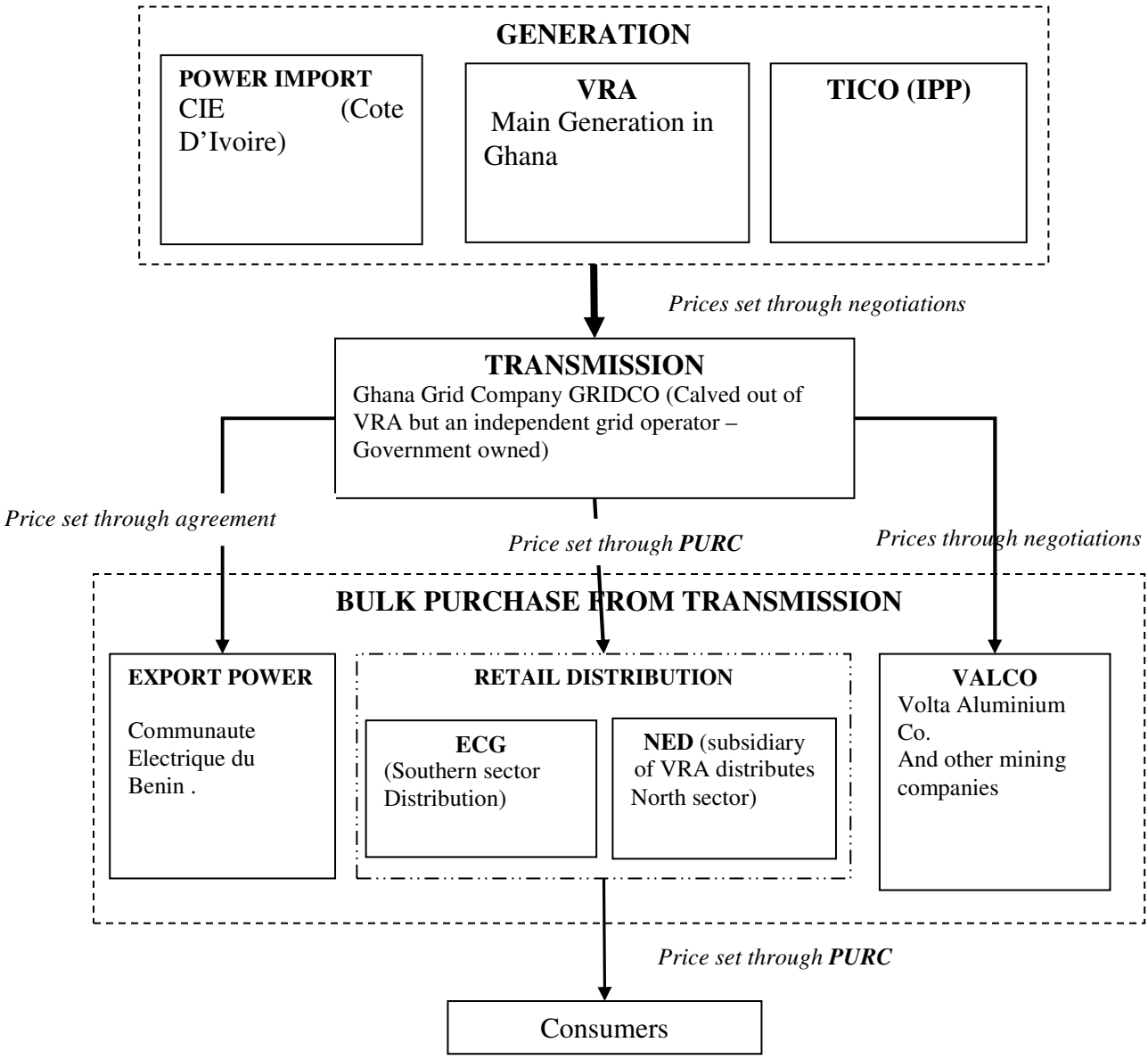

Figure 2.4 showing the current structure of electricity sector in Ghana. Inspired by Ministry of energy structure of the electricity sector in Ghana in PSIA Report, 2004

2.3.1 Generation

As can be seen in *figure 2.4*, there are three main proponents of electric power generation in Ghana, i.e. from VRA being the largest and most influential, from foreign imports (CIE Cote D'Ivoire) and from joint VRA and private partnership. However, the main discussion and description of electric power generation focuses on VRA. Below are a brief description, history and primary functions of the Volta River Authority.

Institution: Volta River Authority *(VRA)*

Enabling Legislation: Volta River Development Act, Act 46, 1961

Brief History: The Volta River Authority *(VRA)* formally came into existence on 26th April 1961, under the Volta River Development Act, Act 46 of the Republic of Ghana. The Authority's primary function is to supply electrical energy for industrial, commercial and domestic use in Ghana. VRA started with the development of the hydroelectric potentials of the Volta River and the construction and maintenance of a nation-wide grid transmission system. Today, it has assumed responsibility for the development of other energy potentials of the Republic of Ghana as well.

Primary Function: The Authority's primary function is to generate electrical energy for industrial, commercial and domestic use in Ghana. Generation of Electricity, Management of Volta Reservoir and related activities. Until recently, the VRA also was responsible for the transmission of electric power in the country. However, since the last year, that function has been taken over by a newly created transmission company called Ghana Grid Company (GRIDCO).

2.3.2 Transmission

Institution: Ghana Grid Company *(GRIDCO)*

Enabling Legislation: Volta River Development Act, Act 46, 1961 as amended

Brief History: As part of the power sector reform that was initiated in the beginning of 2004, the parliament of Ghana made an amendment to the Volta river development Act, Act 46 to create an independent transmission company in 2007.

Primary Function: Separate Transmission Company wholly-owned by government to offer level playing field for all participants in power market

2.3.3 Distribution

A. Southern sector of Ghana

Institution: Electricity Company of Ghana *(ECG)*

Enabling Legislation: companies code, 1963 *(Act 179)* limited by shares on the 21st day of February, 1997.

Brief History: The first Government sponsored public electricity supply in the country began in the year 1914 at Sekondi using diesel engines. It was operated by the then Railway Administration which extended supply to Takoradi in 1928. The advent of the Volta Dam at Akosombo managed by the Volta River Authority *(VRA)* occasioned the spread of electricity wider to various parts of the country until 1967, when the ECG was born by NLCD 125 making it an autonomous organization to operate purely on commercial lines.

Primary Function: To supply and distribute electricity within Ghana. It also purchases electrical energy in bulk from VRA for distribution. To construct, re-construct, assemble, repair, maintain, operate or remove electrical generating stations, sub-transmission lines, transformer sub-stations, electrical appliances, fittings and installations. To sell, hire, or otherwise dispose of electrical appliances and fittings. It also operate, maintain, supervise and safe control of network operations. Market, distribute, sell and bill electric power to customers and collect billed revenue.

B. Northern sector of Ghana

Institution: Northern Electrification Department *(NED)*

Enabling Legislation: A subsidiary of Volta River Authority

Brief History: as a government policy to extend electricity and encourage investments in the three northern regions of Ghana, NED was instituted as subsidiary of VRA to take care of distributing electric power to these areas. These regions of Ghana are sparsely populated and have one of the low population densities in the country and also high poverty level.

Primary Function: distributes and supply electric power to the four northern regions *(Brong Ahafo, Northern, Upper west and Upper East – see figure 2.1)* in Ghana under the supervision of the Volta River Authority.

2.3.4 Regulatory and Monitoring

A. Standards of Performance and Code Of Practice

Institution: Ghana Energy Commission *(EC)*

***Enabling Legislation**:* Established in 1998 by the Energy Commission act 1997 *(Act 541)* (*see Appendix CD+C for full legislation).*

Brief History: The Energy Commission is a statutory body corporate established by the Energy Commission act 541m 1977. The Commission was formally inaugurated on November, 7 1999. The Commission consists of seven commissioners appointed by the President of Ghana in consultation with the council of state.

Primary Function: To advice the ministry of energy on the policies for efficient use of electricity and safety of supply with regard to other energy sources. Set standards of performance and technical and operational rules of practice for the supply, distribution, sale of electricity and natural gas, and petroleum products to consumers by public utilities. The Commission's foremost mandate is however the issuance of licenses to all operators in the energy sector and the establishment and enforcement of standards of performance for public utilities, petroleum product marketing companies and their retail outlets (*Energy Commission official website, accessed 29/05/08).*

B. Tariff Regulation. Utility – Consumer Cooperation

Institution: Public Utility Regulatory Commission of Ghana *(PURC)*

Enabling Legislation: Act of parliament *(ACT 538) (see Appendix CD+A for full legislation)*

Brief History: The Public Utilities Regulatory Commission of Ghana is an independent body set up to regulate and oversee the provision of the highest quality of electricity and water services to consumers. In 1997, an Act of parliament *(ACT 538)* established the public utility regulatory commission to regulate and oversee the activities of the utility companies in the country. There are three main utility companies in the country, the electricity company of Ghana *(ECG),* VRA and the Ghana water company limited *(GWCL).*

Primary Function: Provide guidelines for rates to be charged for the provision of utility services. Monitor and enforce standards of performance for provision of utility services. Examine and approve water and electricity rates. Promote fair competition among public utilities. Receive and

investigate complaints and settle disputes between consumers and public utility. Protect the interest of consumers and provides of utility services *(PURC official website, accessed 29/05/08).*

NOTE: the Energy Foundation of Ghana is discussed in chapter five of this report. This body is the official designated institution by the Ministry of Energy to implement its energy efficiency policies and also educate the general public on energy conservation and end use efficiency methods. The Energy Foundation (EF) does not fall under any of the above classification hence the omission in this chapter. As mentioned earlier chapter five discusses into details the saving potential of promoting end use efficiency in residential and commercial sectors and the Energy foundation key role in ensuring this.

CHAPTER THREE

POLICY FORMULATION, KEY STAKE HOLDERS IN THE ENERGY SECTOR IN GHANA

Purpose: this chapter relates the policy formulation flow in the energy sector especially the electricity sub sector. The chapter also discusses the various key stake holders in the electricity sector. The discussion of the various stake holders centre on their focus area, their interest and level of influence when it comes to electricity policy and especially setting of electricity tariff.

3.1 Policy Formulation Flow

Figure 3.1 below shows a summary of the flow of policy making in the energy/electricity sector in Ghana. The National Government formulates the broader and bigger policy frame work *(including the energy sector)* to guide the national development of the country. From there any detail policy framework concerning the energy sector *(such as the various subsectors, institutions etc*) is formulated by the ministry of energy. The ministry then sends the policy frame to parliament for a final approval of the policy by passing as Act of parliament for it to become law. Such Parliamentary Act will establish various units and institutions that will oversee the day to day of the sector policy and implementations.

The illustration in figure 3.1 was drawn based on interview conducted with some stakeholders *(ECG)* and inspiration from literature (*eg PSIA report, 2004).*

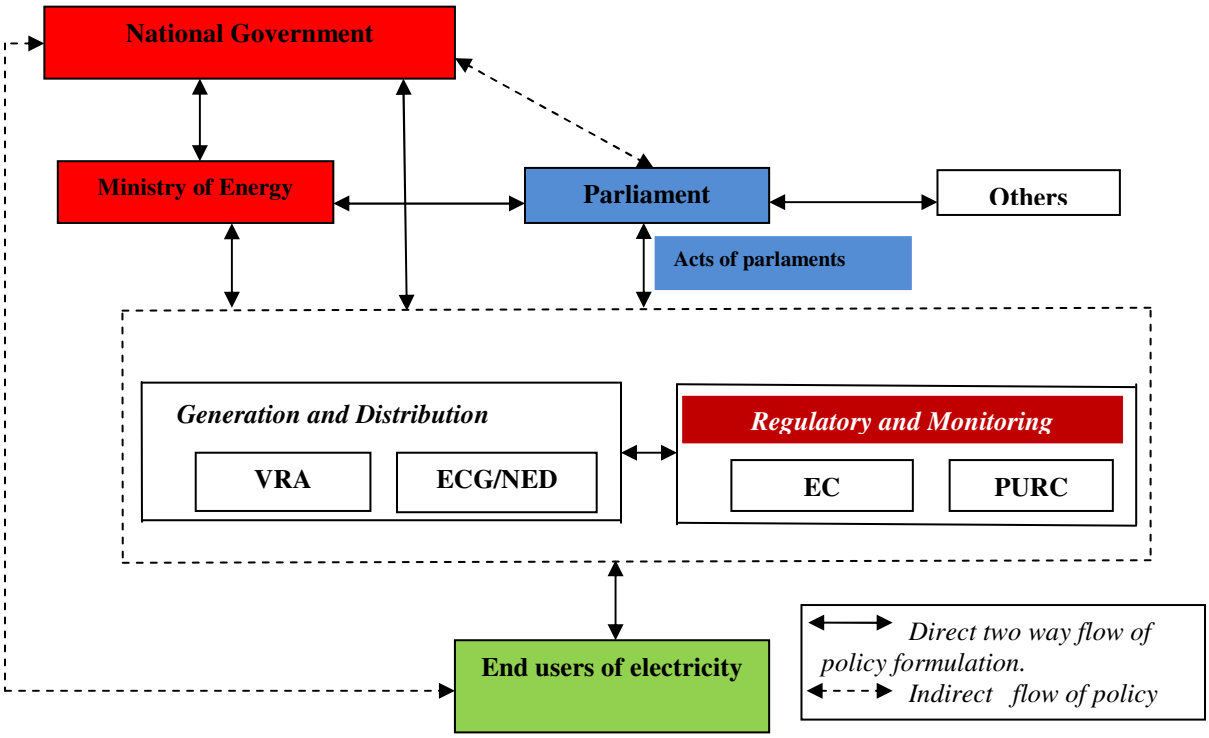

Figure 3.1 authors illustration showing the general policy flow in the electricity sector in Ghana

Colour coding of figure 3.1

Red – the exercutive control. This exercised by the national government through the ministry of energy and other subsidiary bodies such as the energy commission and the public utility regulatory commission.

Blue – the legislative control. This serves to check and legally *(in the sense of the constitution)* mandates the policies and set up regulatory bodies through legislative instruments like acts of parliament that established the energy commission.

Green – this represents the end users who through public protect and "voting power" exercises their power and can even reverse some exercutive and legislative controls.

3.1.1 National Government

The constitution of the fourth Republic of Ghana which came to being in 1992 gives the Government of Ghana the executive powers to set up ministries subject to parliamentary approval to run various sectors of the country for a four year term for a maximum of two terms

in office *(chapter 8 section 78 subsection 1 and 2 of the 1992 constitution of Ghana).* Figure 3-1 shows an indirect two way flow between the central government and parliament, this is so because the central government redirects such through the ministry of energy, however the central government exercise influence on parliament through members of parliament of the ruling government whom some are cabinet members also.

3.1.2 Ministry of energy

The Ministry of Energy has the overall mandate to develop and implement the energy sector policy and also to supervise the activities and operations of the major utility institutions in the energy sector. Therefore, the activities institutions such as the Volta River Authority, the Electricity Company of Ghana, Ghana National Petroleum Corporation, Tema Oil refinery etc comes under its supervision (Ministry of Energy of Ghana). Unlike the central government, there is a direct tow way flow *(see figure 3.1)* the ministry of energy and parliament because any central policy dealings for the energy sector is done though the ministry of energy.

3.1.3 Parliament

Chapter ten section 93 subsection 1 and 2 of the constitution sates that "There shall be a Parliament of Ghana which shall consist of not less than one hundred and forty elected members. Subject to the provisions of this Constitution, the legislative power of Ghana shall be vested in Parliament and shall be exercised in accordance with this Constitution." as the legislative arm of the government, all national policy and laws must pass through parliament for a parliamentary approval before they are enacted and implemented in the country. The setup of elect power institutions such as *VRA, GRIDCO, ECG, EC, PURC* etc were as a direct results of parliamentary enactment as mentioned in *chapter 2.* In the policy flow in the energy sector *(almost the same case with other sectors)* parliament serve as the major middle entity between initial policy formulation and actual formulated policy.

3.1.4 Others

There are other institutions and organisations involve in the energy sector but in the non electric power sector. Mostly they deal with protroleum products and reserves hence are are seen as been out of the scope of this study being the end use efficiency in the electricity sector. Some of the excluded institutions are Tema Oil Refinery (TOR), Bulk Oil Storage and Transport Limited

(BOST), Ghana National Petroleum Corporation (GNPC), Ghana Oil Company Limited (GOIL), Ghana Cylinder Manufacturing Company (GCMC), National Petroleum Authority (NPA), etc. However a summary of these institutions and their primary functions are given in table 3.1 below.

Non Electric Institutions	Primary Functions
Bulk Oil Storage andTransport Limited (BOST)	Covered under the Energy Commission Law (Act 541) of 1997. Strategic Storage of Petroleum Products. It is also to implements the government's policy to ensure stability in the supply and price levels of petroleum products. It is to advise the government on the draw-down procedure for served stocks in case of there an interruption of normal supply of petroleum production.
Tema Oil Refinery (TOR)	Was incorporated in 1960 under the companies' code of Ghana. Processing Crude Oil into various finished Petroleum Products. Supplies the following petroleum productions into the domestic market; Liquefied Petroleum Gas (Lp Gas) Kerosene, Aviation Turbine Kerosene, Automotive Gas Oil, Premix Fuel, Premium Gasoline, Residual Fuel, Oil etc
Ghana National Petroleum Corporation (GNPC)	The Ghana National Petroleum Corporation Law, 1983 P.N.D.C.L. 64 To facilitate the exploration and development of the hydrocarbon resources of the nation in a systematic manner so as to derive the maximum benefit from such resources.
National Petroleum Authority (NPA)	National Petroleum Authority Act, 2005 Act 691 To regulate, oversee and monitor activities in the petroleum downstream industry and where applicable do so in pursuance of the prescribed petroleum pricing formula. To establish a Unified Petroleum Price Fund; and to provide for related purposes.
Ghana Oil Company Limited (GOIL)	established on 14th June 1960 under the Companies Ordinance (CAP 193). The main business is marketing and distribution of petroleum products in Ghana. The biggest chunk of its sales comes from the sale of Diesel and Gasoline

Table 3.1 showing a summary of other major energy sector institutions. Source: Sector profile Ministry of Energy of Ghana.

3.2 Stakeholders in the Electricity Sector in Ghana

Stakeholder analysis is to identify the key stakeholders and to assess their interests, the ways in which those interests affect decision making. It contributes to the report by identifying the goals and roles of different groups, and by helping to formulate appropriate forms of participation with these stakeholders (Henriksen, 2008). There will be two main steps that will be followed in the

stakeholder analysis; ***a)*** *identifies and list the major stakeholder groups and* ***b)*** *determine their interest, importance and influence.*

This analysis of the stakeholders is to establish various group; private, governmental and foreign interest and level of influence on issues affecting electricity reforms particularly tariff reforms in the country. This is to serve as the background information for further discussion and analysis in chapter chapter six about electricity tariff reforms as a strategy in promoting end use efficiency in the residential and commercial sectors.

The emphasis here is to establish they key institutions that involved in the tariff regulation and how they affect or influence and lobby tariff setting in the country. This will set the basis for discussion in *chapter 4* when tariff regulation as a means of promoting electricity end use efficiency in Ghana. The various stake holders are discussed based on their focus of acti9vity and interest (whether it is for/support or against/oppose economic restructuring) and the level of such influence on the final tariff.

3.2.1 Group Interest, Role and Their Level of Influence in Electricity Tariffs in Ghana.

Broadly, the key stakeholders in tariff setting can be grouped into eight categories. These groupings are based on their general line of work and attention. Each group intend has several institutions with varied level of influence. Remember though that, detail tariff structure, the process of actual electricity tariff is discussed in *chapter5* of this report. This discussion and groupings were greatly inspired and based on an earlier report by Keener and Banerjee, 2005; Ghana Poverty and Social Impact Analysis, 2004 by the Ministry of Energy.

National Authority

- Ghana government
- Ministry of energy
- Ministry of finance

A. Utilities

- Volta River Authority (VRA)
- Electricity company of Ghana (ECG)

- Independent Power Producers (IPP)
- Ghana Grid Company (GRIDCO)

B. Regulators and Monitoring

- Energy Commission (EC)
- Public Utility Regulatory Commission (PURC)

C. End Users

- Residential and commercial customers
- Industries
- Volta Aluminium Company (VALCO) (out of operation for the past three year. Used to consume a third of the countries electric power production and one of the most important bulk customers of VRA. Had a high level of influence on bulk tariff of electricity)

D. National Union Associations

- Trade union congress of Ghana (TUC)
- Ghana civil servants association
- Association of Ghana industries (AGI)
- Ghana chamber of mines (GCM)

E. Civil society and Organizations

- Energy Foundation
- Ghana Association of Consumers
- Print and Electronic Media

F. Political Groups

- New Patriotic Party (NPP)
- National Democratic congress (NDC)
- Convention People Party (CPP)
- Other Political parties

G. External Donors

- World Bank
- International monetary fund (IMF)
- DANIDA

Stakeholder	Focus area and interest	Level of influence on tariff
	A. National Authority	
Ghana government	Minimise social impact of tariff adjustments on consumers. Ensuring good financial standings of the utility companies and mitigating any political fallout because of the tariff adjustments. Would want to disassociate it self from any tariff adjustment	Exercise a very high influence since it owns the utilities and appoints some influential board members. Could influence the timing and quantity of tariff adjustment to suit its political agenda.
Ministry of energy	Has the overall oversight of all the energy policy including electricity sector thus would is interested in the right tariff adjustment to promote its policies.	Since it set the bench mark for performance of he utility companies thus it could provide and influence the PURC decisions. Also the minister of energy is a cabinet member thus could have a level of influence in deliberating decisions affecting tariff adjustments at cabinet meetings.
Ministry of finance	Interested in how any tariff adjustments affect the macroeconomics of the country and to minimise any of such social and economic cost.	As a powerful cabinet mister, could influence decisions of government on PURC and affecting the rate and amount of subsidy to the utilities. Determines when and how such subsidy is paid to the utilities.
	B. Utilities	
Volta River Authority (VRA)	Interested in tariff adjustment that will reflect and cover production cost including cost for some capital stock. Seek ways to reduce production cost and become more competitive. Much interested in Bulk Supply Tariff (BST) than Distribution Service	Very power in propose new tariff adjustments to PURC thus have little influence on the final outcome of the tariff adjustment.

	Charge (DSC) than	
Electricity company of Ghana (ECG)	Seeking to charge tariffs that will cover full production cost (economic cost) and improve its capital. More interested Distribution Service Charge (DSC) than Bulk Supply Tariff (BST).	Again can only propose but has less influence on the final tariff adjustment.
Independent Power Producers (IPP)	Interested in full cost recovery and consumers paying realistic cost that will reflect production cost. Maximise their profit levels	Has little influence in deciding any tariff adjustment and tend to go with VRA proposal
Ghana Grid Company (GRIDCO)	Newly setup company and seek to establish a level playing field for all the distribution companies	Involve in the proposing new tariff adjustments but has little influence in deciding the final outcome.
C. Regulators and Monitoring		
Energy Commission (EC)	Interested in granting licenses, setting and monitoring standards of performance of the energy sector. This includes generation, transmission and distribution of electric power.	There is a financial and investment implication of any high standards set by the EC on the all the utilities thus could influence tariff adjustment through such standards as utilities may want to recoup any additional financial investment through tariff increase.
Public Utility Regulatory Commission (PURC)	PURC is an independent body that has a mandate to oversee the tariff setting process, to represent the interests the consumer and utilities, with final decisions that, in principle, are not subject to any executive or legislative consent.	Has the legal power to approve or adjust any final proposed tariff thus exercise a very high level of influence on final tariff adjustment. Since it currently depends on government for bulk of its funding, it decisions could be influenced and this has caused some to raise questions on whether it is put under pressure by Government of Ghana during election year.
D. End Users		
Residential and commercial customers	Low and cheap electricity prices and often stress on stable and reliable supply	Most often don't have much say but are very influencial group twhen issues are being discussed in an election year and often use the print and the electronic media to express their disactisfaction of tariff increases
Industries	Want low and affordable tariff	Often use their national private

	prices but are more concerned with security, continues and stable supply of power as power outages affect their production levels and decrease profit margins	associations such as the Ghana Association of Industries to influence and lobby for lower prices. Has not much influence of the final outcome of tariff prices
Volta Aluminium Company (VALCO)	Buys power directly from VRA and for so many years consumed almost a third of the electricity in the country. Pays very low bulk tariff price in foreign currency (USD) through a long time negotiated contract with the VRA. But now consumes less electricity due to their announcing bankrupt in 2003 and drastically reduce their production activities in the country	Negotiated their own bulk tariff prices with VRA and their purchase is considered as export hence give VRA the much needed foreign currency and has a lot of influence in deciding the price of bulk price but not the end user tariff
E. National Union Associations		
Trade union congress of Ghana (TUC)	Interested in negotiating realistic salaries and wages for its members and use tariff adjustment as one of its tools during negotiations arguing that there should be corresponding adjustments in salaries of any tariff increase.	As one of the largest trade unions in the country, it is very vocal and can organize a nationwide protect of any tariff adjustment through its members. Thus they assert their influence on any tariff adjustment through the government
Ghana civil servants association	Interested in negotiating realistic salaries and wages for its members and use tariff adjustment as one of its tools during negotiations arguing that there should be corresponding adjustments in salaries of any tariff increase.	It is very vocal and can organize a nationwide protect of any tariff adjustment through its members. Thus they assert their influence on any tariff adjustment through the government
Association of Ghana industries (AGI) and Ghana chamber of mines (GCM)	Interested in protecting its members from any tariff increases and demands reliability of supply from utilities.	Very organized and well resourced associations. Exert most influence during PURC public hearing.

F. Civil society and Organizations		
Energy Foundation	A government – private collaboration foundation interested in promoting energy end use efficiency and conservation.	Well resourced and exert its influence on tariff adjustment through both the print and electronic media. Its campaign has helped minimize the impact of tariff increases on all categories of electricity user through the adoption of energy efficiency measures. Has been advocating informally for the payment of economic tariffs so that end-user will be forced to adopt energy efficiency and conservation measures.
Ghana Association of Consumers	Interested in final consumers welfare and social impacts as a result of tariff adjustment and has a representative in the PURC	Tends and only exert some influence during public fora of PURC but less influential in influencing the final tariff adjustments.
Print and Electronic Media	Interested in informing and educating consumers about any tariff adjustments. usually interested in being the first to break the news on tariff increases	"Usually the main source of information to residential and nonresidential consumers regarding tariff increases; could misinform consumers regarding the rationale for tariff increases; provide forum for "voiceless" group of consumer to present their perceptions, opinion and objections to tariff increases; provide avenues for regulators, utility and all relevant stakeholders to discuss rationale and implications of tariff increases; usually hint the public about proposed or eminent tariff increases before any formal announcements would be made by the PURC."
G. Political Groups		
New Patriotic Party (NPP)	Current ruling party in the country and is interested in satisfying the basic needs of the masses in order to retain political power.	Has majority in parliament and can easily influence policies or legislation for any tariff adjustment in Parliament. The party can exert a high influence on the president in influencing the PURC on any tariff adjustments.

National Democratic congress (NDC)	The largest opposition party in Ghana and until 2001 ruled for 8 years and seeks to return to power. Seek to portray the present ruling government as uncaring about the plight of the ordinary Ghanaian and they will be a better choice. Strongly oppose every tariff adjustments.	Forms the largest minority in parliament and could vote against any tariff adjustment legislation. They are more vocal during an election year and exert a substantial level of influence by using the media to inform the public about the effects of any tariff adjustments strongly oppose ant tariff increases.
Other Political parties	There are other political parties such as the Convention Peoples Party started by the first president of Ghana, the People National Convention. All these small opposition parties' acts like the main opposition party the NDC but have less influence.	Limited support and very less influential in opposing or supporting any tariff adjustment in Ghana.
H. External Donors		
World Bank/ International monetary fund (IMF)	Interested in supporting the socio economic activities of the country through giving of grants and loans for specific infrastructural project (e.g. SAP).	Through conditionality, it exerts influence on tariff adjustment by advocating for removing subsidy on utility and charging economic price whilst making provisions for the very poor consumers who cannot afford. It has a high influence on national government in manipulation tariff adjustments.

Table 3.2 showing various stakeholders interest and level of influence in tariff pricing. Source, inspired by Keener and Banerjee, 2005; Ghana Poverty and Social Impact Analysis, 2004 by the Ministry of Energy

Summary

The analysis of the various stakeholders reviewed that there are varied interest and level of influence when it comes to tariff reforms especially increases in tariff prices. To successfully utilise and adopt a policy frame work that will be welcomed by all stakeholders will be a challenge but atleast taken the most urgent and widely expressed opinions will go a long way to inprove the success rte of any tariff reforms that will be implemented.

CHAPTER FOUR

DEMOGRAPHY, ELECTRICITY ACCESS AND TARIFF IN GHANA

Purpose: The purpose of this chapter is to establish the various links between three main chosen demographic factors in Ghana and electricity end use promotion efficiency and how these factors should form an integral of future policies that deal with end use efficiency measures. These factors were selected based on the fact that they present some of the biggest obstacles facing the country as a whole and the electric power sector. With high poverty levels, high illiteracy rates and low access to grid connection, if not properly handled, they could jeopardise any efforts to promote and achieve any concrete results in promoting electricity end use efficiency.

4.1 Introductions

This chapter adopts a descriptive approach and discusses some factors that will be crucial in formulating and implementing the right electricity end use efficiency measures. With more than half of the population being rural, a third of the country below the poverty line and barely half of the adult population (15 years and above) who can read and write, Ghana as a developing nation cannot simply overlook these issues therefore analysing any effects of such incidence on electricity end use efficiency measures could be fundamental in achieving any significant reduction in the electricity used in residential households and commercial buildings. Though there many equally fundamental factors that could have been considered such as the employment/unemployment rates and prices of the electricity itself, these three factors are considered because they provide the background of the basic core characteristics of most under developed countries including Ghana (Turkson and Amadu, 1999 and Barnes et al, 1997). The three factors considered in this report are;

a) The population distribution in Ghana: the geographical distribution as to the population density, rural-urban distribution. *(Note – in Ghana settlements with people numbering 5,000 or more are considered as urban while those less than 5,000 inhabitants are considered rural, Benneh, 1990.)*

b) The economic distribution and lastly: the income distribution of households relating to their spending power and general economic standings.

c) Literacy level: rate and level of adult population (15 years or more) who can read and write, level of education.

The outlay of the factors is illustrated in *figure 4.1* below.

Figure 4.1 shows the three factors considered in this chapter. The broken arrows (double arrows) shows the general interdependence of the factors and the solid arrow pointing to the centre shows that three factors act and influence measures for electric power end use efficiency.

Red boxes – the three main factors considered in this chapter

Gray boxes – other factors that could have been considered

Green box – electricity tariff is separately discussedand analysed in chapter 6

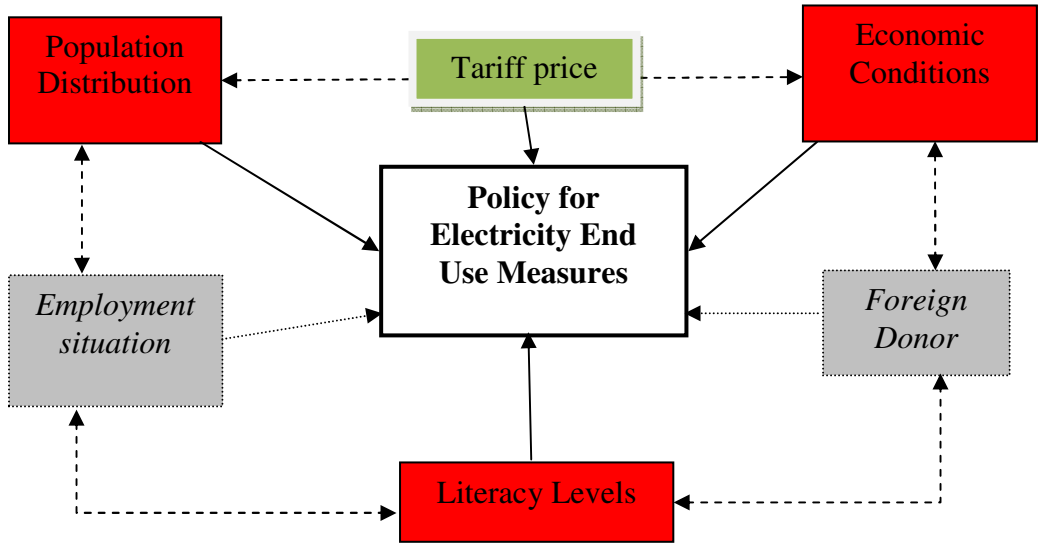

Figure 4.1- authors illustration of three factors critical to electricity end use measures.

4.2 Population Distribution in Ghana and Access To Electricity

With 44% of the population living in urban areas as of 2007 according to the United State population and reference bureau, Ghana´s population is largely rural. According to an estimate by institute of statically, social and economic research of the University of Ghana, 47% of Ghanaians have access to grid electrification. This also includes average of 17% for those in the rural areas of Ghana. The general trend of access to grid electrification tends to decrease towards the northern regions of the country. These areas also happen to have low population densities.

Access to electricity in this northern sector the country is as low as 4.3% compared to approximately 27% in the southern and the coastal belts (ISSER, 2005).

These figures represent great improvement of the population having access to grid electricity. The overall access grew from 39% in 1999 (Ministry of Energy Ghana, 2004) to the 47% in 2005. Much of this increase could also be attributed to the introduction of the *Self Help Electrification Projects (SHEP*) which provides low cost and affordable electricity to rural dwellers.

From table 4.1 below, it can be seen that majority of the Ghanaian population is rural and with the exception of three regions (Greater Accra, Ashanti and Eastern regions) the rest of the country have very low population density. Almost 80% of electricity consumption occurs in the urban areas of the country, therefore any end use efficiency measures targeting these urban hot spots could prove beneficial. This sparsely population distribution could also raise the questions as to whether these remotes town and cities with few residents should be connected to the national grid or small scale and more localised electricity sources such a gas fired plant could be more readily available and less expensive.

As mentioned earlier on, the electricity consumption across the country varies greatly with less rural dwellers with access to electricity though they form the majority of the population with more urban dwellers with access to electricity. Even so, accesses to electricity in the urban areas of Ghana also vary from one region to the other. With the highest population *density (see table 4.1)*, as the largest rural – urban migration destination in the country and largest commercial centre in the country *(with majority of big and light industries),* Greater Accra region consumes

Region	Population (000)	Rural (000)	Urban (000)	Density (per sq. Km)
Western	1,925	1,226	698	80.5
Central	1,594	995	598	162.2
Greater Accra	2,906	358	2,406	895.5
Volta	1,635	1,194	441	79.5
Eastern	2,107	1,379	728	109.0

Ashanti	3,613	1,760	1,853	148.1
Brong Ahafo	1,815	1,137	679	45.9
Northern	1,821	1,337	484	25.9
Upper East	920	776	144	104.1
Upper West	566	476	101	31.2

Table 4.1 – showing the population distribution in Ghana. Source: Ghana Statistical Service, 2000 Population and Housing Census.

Any future electricity end use measures should take into account this rural and urban population distribution in analyzing where the hot spots are and where maximum impact could be made in saving electricity. A typical policy strategy where rural – urban distribution could be in a major consideration is adopting tariff restructuring as a means of promoting electric power end use efficiency in Ghana.

Below is the administrative regional map of Ghana showing the ten regions with rural – urban population distribution and the population density/m^2.

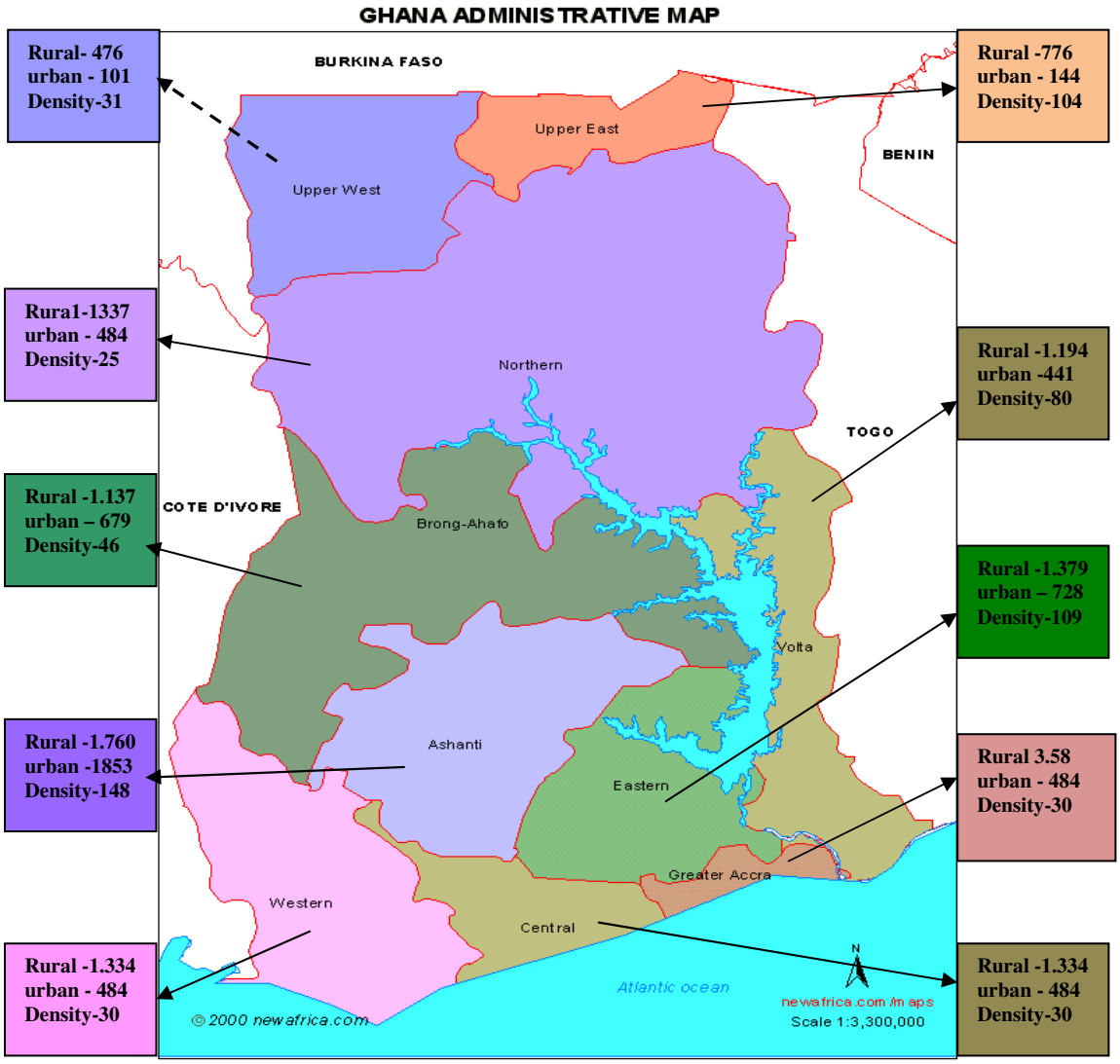

Figure 4.2 showing the administrative regions and population distribution of Ghana

While this report does not call for overlooking and minimising electricity end use efficiency measures targeting rural electricity consumption, it becomes evident that urban and more densely populated regions in Ghana should be the immediate focus of such measures.

On the other hand, the large discrepancy of access to grid electricity of rural and urban dwellers could shape future research of addressing this gap and a new avenue for promoting end use efficiency. Such studies should also help to improve the efficiencies of other readily available sources of energy such as biomass to these rural dwellers along side with electric power end use efficiency.

4.3 Economic Distribution

Another factor that should be given consideration in planning for future electricity end use efficiency measures is the economic situation and distribution in the country. Economic condition of an electricity end user not only determines the ability to pay electricity usage but also the number and type of electrical appliances that are likely to be used by these various dwellings. With nearly a third of the population below the poverty line (Ghana statistical service, 2000), considering and integrating economic standings of electricity consumers in the residential and commercial sector will be important in achieving the desired results for electricity end use efficiency.

Interestingly, the economic distribution of Ghana in terms of livings standards and ability to afford basic needs tend to follow the rural –urban trend, with more people in the urban areas of the country being less vulnerable. According to a study by the Ghana Poverty and Social Impact Analysis (PSIA) by the ministry of energy, approximately 20% of all rural dwellers who use electricity fall below the poverty line. This percentage can even be higher for generally poor regions such as those in the northern part of the country. To help shield some of the electricity usage bill for poor rural dwellers, the Ghana government through the electricity company of Ghana introduced what is term as a "lifeline" customer, i.e. to give consumers in rural areas and very low income groups a fix electricity cost provided they do not exceed the limit of 50kWh for a month. People in this economic bracket in the rural areas often need and use electricity for lighting purpose and other less consuming appliances such as radios.

The income levels across the country could also be identified with dwelling king of dwellings. Different dwellings are either peculiar to the rural areas or urban areas in the country. Also the dwelling type across the country also gives an indication to the economic condition and ability to pay electricity bills. The dwellings types can be group as;

***Compound houses and urban low income house*:** this is the typical housing units found in the rural areas. Normally different individuals and family who are related by long distance relation (extended family) share various rooms in the building but use common toilets and bathrooms. Most often, they do not pay monthly rent. Like many rural dwellers in Ghana, this group of dwellers are among the low income earners and most of them are peasant farmers or other low

income activities. If such a household has access to grid electricity, they all share a single meter and payment of the bills are shared among the different members of the house especially the adults. For this reason, members of the household have a share responsibility to ensure proper use of the electricity to reduce the monthly cost or not to exceed a targeted kWh use or electricity cost. The basic electricity these rural dwellings are for lighting purposes, radio more recently other electrical appliances such as television sets. Though most rural dwellers do not use many electrical appliances, it can be observed that there is direct relationship between improve economic standings and purchase of new electrical appliances. The worries though from electricity end use perspective is that, majority of rural dwellers tend to purchase used (second hand) electrical appliances mostly imported from the developed countries. These electrical appliances tend to be less electricity efficient not to mention the environmental and other health hazards.

It must however be emphasized that, there are similar dwellings in the urban areas of the country but unlike the rural compound housing, the tenants in the urban centres are usually unrelated. Also modern compound housing units in the urban areas can be single storey and a blend of modern architecture. Different family units share singles rooms and have shared utilities. The amount of electricity each family unit pay is based on the number of electrical appliances and use. The total electricity cost for the whole house is divided by the number of appliances and lighting points in the house and each family pays for the number of points it uses.

Single family dwellings: These dwelling type are normally found in the urban and cities in the country and is mainly characterised by one family. This dwelling type is similar to the single family dwelling type found in many developed world like in Denmark. Unlike compound houses, these types of dwelling generally have high income levels and often use many electrical appliances. For such dwellers, tariff forms a small proportion of their monthly income and therefore they are in better position to afford tariff cost. It is not uncommon to find the use of room air conditions in such dwellings.

Slums households: these dwellings are found in the densely populated cities and towns in the urban centres. Often this is as a result of rural-urban migration and though this kind of dwellings is found in urban areas they often characterised with poor sanitary conditions and other social

amenities. Economic conditions of people that dwell in slums in urban centres in Ghana vary according to individual members of the dwellers but are among the poorest in the urban economic status. Electrical appliances usage among this group tends to be basic such as television, radio.

	Connection rate 2000	**Inhabitants with electricity Million**	**Average household tariff USc/kWh**	**Social tariff USc/kWh**	**GDP Per Capita (PPP) (2002)**
Ivory Coast	50	8	8.5	5.0	1500
Ghana	43	8	7.2	6.3	2130
Benin	22	1.4	12.4	10.4	1031
Burkina Faso	13	1.8	14.9	13.2	1012
Togo	9	0.4	10.7	10.5	1458

Table 4.2 – comparison of electricity tariff with Ghana neighbours. Source: keener and Banerjee, 2005.

Table 4.2 shows a tariff comparison for Ghana and some West African countries. With more than half of the population below the poverty line, sub Saharan Africa population lack of basic amenities including electricity is one of the highest in the world. Yet, closer look at 4.2 reveals that cost of tariff prices among different countries. It can clearly be seen that, Ghana has one of the lowest price for electricity among her closest neighbours. Not only that, it can also be seen that Ghana also has a relatively high rate of access to electricity. And as mentioned earlier much of this accessibility and connection is found in the urban areas.

According to the Ghana Living Standard Survey (GLSS), conducted by the ministry of energy under the Ghana poverty and social impact analysis of tariff (PSIA), about 12% of all electricity users in Ghana are considered poor, that is fall below the poverty line. This therefore suggest that majority of electricity users especially in the residential and commercial sectors are in a position or will be able to afford “a reasonable” tariff charges.

Regions	Poverty incidence (%)
Greater Accra	7
Western	25
Ashanti	36
Volta	37
Brong Ahafo	39
Eastern	48
Central	50
Northern	69
Upper West	88
Upper East	89
GHANA	42

Table 4.3 showing the poverty incidence rate across the ten regions of Ghana. Source: Ghana Government.

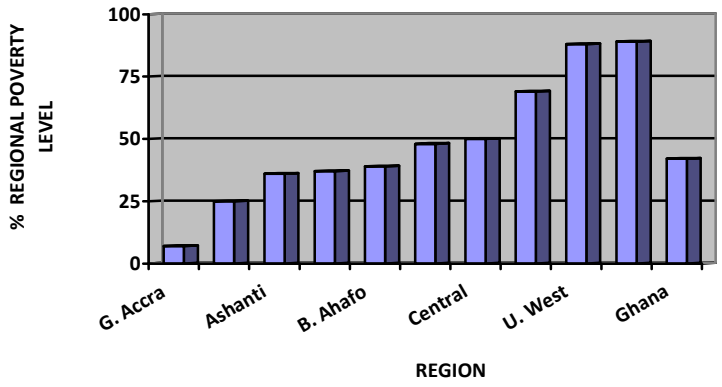

Figure 4.3 showing the regional poverty incidence level in Ghana based on table 4.3

4.4 Literacy Distribution

Literacy (being able to read and write) or education plays an important role in an individual life in that it helps an individual's to make informed decisions or receive information that impact his or her well-being.

By literacy rate, this report makes reference to the number of people in Ghana who are 15 years or above and can read and write. According to the last population and housing census in 2000, the literacy rate in Ghana was around 60% with 66.4% being male and 49.8% women. Even though we can expect these figures to have improved a little bit, it can generally be said that the

literacy rate in Ghana is low. Low literacy levels can hinder rapid economic growth given the fast pace of technological advancement.

This is an important factor that should be given consideration for any future policy formulation and implementation is the literacy distribution across the country. This is crucial especially in implementing any policy formulated. There is no documented report in Ghana to suggest that, people with higher educational level will be more pro electricity efficient compared to people within a the lower educational level. However differences in these could pose a problem in disseminating vital end use efficiency measures. It is reasonable to understand why Denmark electricity end use efficiency measured could be easily promoted. With almost 100% literacy rate, vital programmes concerning efficiency measures could easily reach end users through the print and electronic media. Achieving an appreciable level of success with end use efficiency measures will first require educating the final users of electricity.

Again, the illiteracy rate levels follow the general pattern of "rural-urban" line, with higher number of those who cannot read and write in the rural communities and vice versa. Also the level of literacy (educational level) is closely linked with the economic status of electricity end users. In Ghana, consumers with higher level of education tend to fall within the higher income group and those with less education or those who cannot read and write at all fall under the low income or even under the poverty line.

4.5 Summary

Ghana as a developing nation will continue to face these critical factors as she continues on her path to achieving a middle income status by 2020.

So far we have discuss and explain how the population distribution, the economic status of electric power consumers and literacy levels should be an integral part of any future electricity end use efficiency measures. These three factors will further be examined in chapter six in relation to specific strategies that could be adopted in promoting end use efficiency in Ghana. The three factors will play in major role in analyzing which strategy will be best suited for Ghana in promoting electricity end use efficiency.

4.6 Electricity Tariff Structure in Ghana

The Public Utilities Regulatory Commission Act (*Act 538)* in 1997 mandates the PURC to regulate and set up utility prices in Ghana. It is the only legitimate body in Ghana who decide the final prices of tariff both for electricity and water. Section 19 of the commissions Act mandates the commission to publish any of such adjustments to the public.

Electricity tariff reforms in Ghana is not new and the first attempt to reform tariff dates back in the mid 1980s (Keeneer and Banerjee, 2005b). The objective of such reforms was to make tariffs reflect economic cost yet that will be affordable to final consumers. In more recent years though, another added incentive of tariff reforms to reflect economic cost is to force or encourage final electric power users to adopt and promote end use efficiency (Baiden, 2008). Often, electricity tariff reforms that lead to increases in electricity prices are met with a lot of opposition from the public especially those in the organized groups such as the Trade Union Congress (*TUC),* the Association of Ghana Industries (*AGI),* opposition political parties, the media and the general public (Keeneer and Banerjee, 2005b). However, the utility companies have always pushed for "realistic and economic tariff" to reflect their marginal cost of production.

In line with consumers paying economic tariff, a tariff reform in 1997 brought about a 300% increase in electricity prices which led to a nationwide uproar and protect in the country. This change the tariff reforms from the government and led to the establishment of an "independent2 body backed by legislation in the same year 1997 to oversee all tariff reformation and adjustment process both in the water and electricity sector. So during the last quarter in 1997, the Public Utility Regulatory Commission (PURC) was established mandated to set and monitor tariffs in the country.

Table 4.4 shows the sequential tariff reforms that have taken place in Ghana since the 1970s.

Year	Tariff Reform Event
1976–86	No tariff reforms
1986	Marginal Cost (Long Run Marginal Cost - LRMC), classifying consumers based on groupings of consumers who impose similar costs on the systems, and grouping residential consumers by level of consumption. Progressive with lifeline consumption of 50 kWh applying to all consumers. Also adopted uniform national tariff structure.
1988	The level of tariffs recommended by Coopers & Lybrand is substantially adopted; it approximates 75 percent of LRMC.
1989	Tariffs increases, ranging from 6% for low-income consumers to 20% for non-residential consumers, were implemented in order to enable VRA to continue to earn an 8% and ECG a 6% Rate of Return (ROR). However, in fixing the tariff, the Government of Ghana expressed concerns at the prospect of further adjustments to domestic tariffs to reflect recent devaluation and inflationary pressures at a time when the service remained unreliable. The Government of Ghana expressed the wish to re-examine certain aspects of the 1986 tariff study, and this leads to commissioning of next major tariff study (ACRES).
1990 - 1992	ACRES study points out: The inverted block rate structure recommended by Coopers and Lybrand was cumbersome to administer and a source of customer discontent. Recommended adoption of "adjusted LRMC" – an LRMC adjusted to reflect the financial requirements of the utilities. Recommended merging of all residential tariff structure into a single energy rate with the exception of the lifeline tariffs New electricity tariffs introduced in January 1992 based on the recommendation of ACRES International, which was actively supported by the World Bank
1993	The Government of Ghana agrees to adopt a formula-based approach to tariff adjustment and provide for the regular and systematic adjustment of the tariff thereafter on the basis of the agreed formula. Essentially the formula provided for phasing-in prevailing tariffs to LRMC adjusting for inflation and exchange rate movements. Tariff increases were implemented in January 1993 and an agreement reached for further increases in 1994 and 1995 within the framework of this agreement.
1994 - 1997	Tariffs continue to increase per the agreed formula, although the focus is on a set Rate of Return for the utilities rather than LRMC.

1998 - 2002	PURC tariff adjustments
2003	Tariff formula allowing for automatic adjustment to reflect exchange rate and inflation is enacted and supposed to take effect July 2003. First automatic adjustment of the tariff per the formula.
2005	PURC scheduled to carry out major tariff review.

Table 4.4 showing the tariff reforms in Ghana. Source: taken from Keeneer and Banerjee, 2005b and World Bank Appraisal report 1993, 1995.

4.6.1 PURC Tariff Rate Setting Process

The PURC by law is obliged to follow *figure 4.4* when deciding on the tariff adjustment.

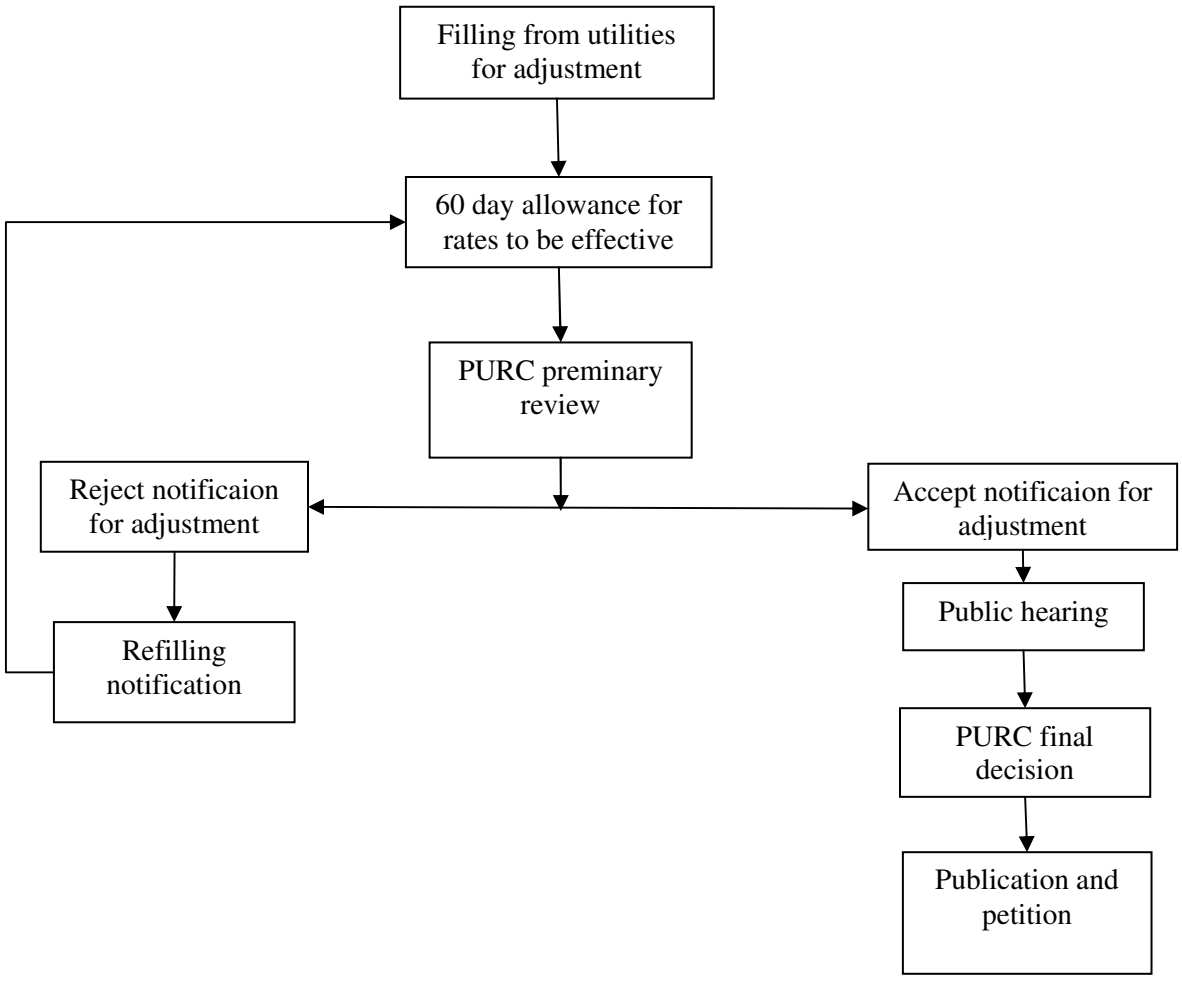

Figure 4.4 showing PURC tariff setting processes. Source; PURC, Ghana.

Pre-filling notification: the utility company will file a notification to the PURC for any needed adjustments in tariff. The notification should be filled at least 60 days from its effective date.

PURC Preliminary review: The PURC upon receipt of the necessary documentation shall review it and notify the utility company of its comments, if any. The utility company after receiving the comments shall respond to them within a maximum period of fourteen calendar days.

Rejection and refilling notification: If the filling of the utility is rejected, it shall re-file within a maximum period of fourteen calendar days for consideration by the PURC

Public Hearing: When the PURC accepts the filling of the utility company, it shall organize "public hearings" to give the opportunity to other stakeholders to comment on the proposals. Prior to the public hearing, the utility company shall publish its tariff proposal in the print media. The publication of the proposed rates should be done at least 14 days before the "public hearings".

Final tariff setting and petition: after internal and hearing public concerns and deliberation, the PURC will announce its final tariff adjustment and receive a presidential signature and finally publish in the print media. However, if any group or individual has a petition on the final decision, it should be done it should be done within ten calendar days from the first date of decision publication and the review should take place within ten calendar day of first receiving any such petition.

4.6.2 Components of Residential and Commercial Tariff

There are six basic component of the end user tariff (Baiden, 2008). These include;

- The bulk generation charge – from the generation company (*VRA*)
- Transmission service charge – from the transmission company (*GRIDCO)*
- Distribution service charge – from the distribution company *(ECG and NED)*
- Value Added Tax (VAT of 17.5% for Ghana)
- National Health Insurance Levy
- Street light levy

4.6.3 "SHEP" and "Lifeline" Tariff

- ***Self Help Electrification Project – SHED:*** in 1989 the government of Ghana embarked on a country wide expansion and access to grid electrification especially among the rural

dwellers in the country. That led to the introduction of a development project called the Self Help Electrification Project *(SHED).* This project is basically for rural communities who have no access to grid electricity so the people come together with their opinion leaders to contribute to the total cost of extending grid electricity to the community. This can be done both in real money or in kind say buying the electric power poles and most often in the labour force. When this is done an application for power is sent to the right distribution company either ECG or NED for power and the company will access the application and if qualified will connect the community to the national grid with the government subsidising the total cost involved (Baiden, 2008). This scheme greatly increased the number of rural communities with access to grid electrification during the 90s. The figure below shows the extent various regions in Ghana have benefited from the SHED project.

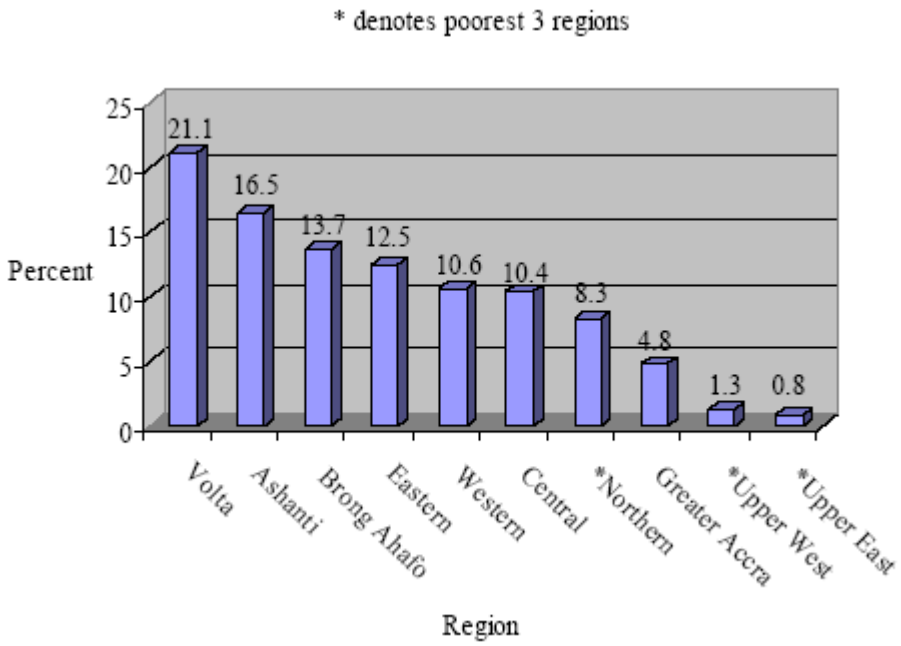

Figure 4.5 showing the regional share of SHED projects as of 2003. Source: Ghana Government.

- ***Lifeline Tariff:*** To cater for the payment of tariff of very low income consumers, the government through the utility company introduces what is called "the lifeline tariff" in the mid 90s. This a flat rate tariff for very low income consumers (like those in the rural areas) to pay when they consume 50kWh or less. However in 2002, the government of

Ghana decided to pay the lifeline tariff as a subsidy. The principle behind this is that "the lifeline philosophy contends that electricity is an essential service rather than a luxury and people of low income should not be deprived of it because they cannot afford to pay the full cost of supply.' The lifeline supply level and tariff is to ensure that, very low income customers can afford to meet basic needs" (Ministry of Energy, 2004). So the lifeline tariff was initiated to protect very low income consumers from tariff adjustments and increases.

CHAPTER FIVE

SAVING END USE ELECTRICITY – FOCUS ON RESIDENTIAL AND COMMERCIAL BUILDINGS

The purpose of this chapter is to discuss and explain the extent of the saving potential by promoting end use efficiency in the electricity sector in Ghana. The focus is to use examples from the cases from the residential and commercial sectors to demonstrate the saving potential in this area. Also the chapter discusses the main organisation mandated to promote and embark on energy efficiency including electricity end use efficiency in the country – The Energy Foundation of Ghana.

5.1 Introduction

Residential electricity demand and consumption forms a substantial percentage of total consumption of Ghana´s electricity *(see figures 1.2 and 1.3 in chapter one).* This increasing demand in a normal sense could be accounted for by an increase in grid connections and building of new power plants. However as mostly have been the case employing conservation and end use efficiency measure is far cheaper than building new power plants. As Amory Lovins an energy expert from the Rocky Mountain Institute in UAS puts it in William Kemps book "it is far less expensive and environmentally more responsible to generate *negawatts* than *megawatts*" (Kemps, 2005). As living standards improve, the penetration of appliances in higher and middle income households will also increase. Furthermore, as more and more communities are connected to the grid, they will naturally demand more electrical appliances, particularly lighting and refrigeration. According to *Ghana Residential Energy Use and Appliance Ownership* Survey (Constantine et al, 1999), the average household in Ghana contains more than 7 people. This implies that there are currently approximately more than two and half million households in the country with the potential to own electrical appliances. Most of these appliance owners or potential owners are concentrated in urban areas, which account for only 37% of the population. By 2010, assuming an annual growth rate of 2.7%, Ghana's population will surge to almost 25 million. All other factors constant, that would mean over 3.5 million households.

5.2 Energy Foundation – Steering Energy Efficiency in Ghana.

The energy foundation of Ghana (EF) is a public – private partnership, non profit institution established in 1997 and it is devoted to the promotion of energy efficiency and renewable energy as a means of sustaining the energy demands in Ghana. This institution is registered in Ghana as a company limited by shares under the company´s code of 1963 of Ghana. It is the major institution with the sole aim of specialising and offering energy efficiency and renewable energy solutions to both the public and the government and in the residential, commercial and the industry sectors of the Ghanaian economy *(Energy Foundation official website, accessed 2-06-08).*

However the promotion of energy efficiency has not always been the function of the energy foundation. It was first initiated by the then National Energy Board (NEB) in the 1980s and later implemented by the Ministry of Energy (MoE). The initial focus was on industrial electric power and fuel consumption rather than on residential efficiency because as can be refered to in chapter 2 of the report, until 2005 the industrial sector energy use far exceeded that of residential and commercial sectors usage. However, due to; ***a)*** low hydro energy prices in the country during the 1980s (Amadu and Turkson, 1999*)* ***b)*** the general apathy of the public towards government initiated programmes *(*Energy Commission, 2002a*)*. So in 1997 as part of the structural reforms in the energy sector in the country which resulted in the separation of key areas of the energy sector from the Ministry of Energy to other institutions. One of such areas was delegation of the promotion and implementation of electricity efficiency to the Energy Foundation. As mentioned earlier it was a partnership between a public and private (*some of whom are listed below)* and the main aim of this partnership was to remove and avoid the sluggishness and bureaucracy and to increase the public acceptance of such an institution. Also, another objective of this partnership was to pull resources from both the government and the private consumers to focus the promotion of energy efficiency in Ghana.

In the spirit of these objectives, the foundation is governed by an executive council which is made up of the following members *(the list is primarily taken from the Energy Foundation official website but has been edited by the author):*

- Volta River Authority (VRA – Government owned)

- Electricity Company of Ghana (ECG – Government owned)
- Association of Ghana Industries (AGI – Private)
- Private Enterprise Foundation (PEF- Private)
- Ghana National Chambers of Commerce and Industry (GNCCI – Private)
- Ghana Chambers of Mines (GCM – Private)
- Volta Aluminium Company Ltd (VALCO – Government-private, closed down production for the past three years).

Thus it can be said that the Energy Foundation represent the consumer interest both individuals including residential electricity users and firms to the government and the other way round. *(Note, EF takes care of the actual end use promotions technigues and procedures while PURC is charge of hearing customer complaines and dissacfaction of the utility services and unfair treatments).* To fulfil its mission of promoting energy efficiency in the country, the Foundation needed to overcome two main barriers. The first one was the general low level of energy usage control awareness and the second was the apathy towards energy efficiency and conservation. In many regards, the focus of energy concerns in the country has been the high cost associated with the energy supply *(supply side concerns)* without asking much from the end use efficiency *(demand side of the equation).*

Since most of the institutions mentioned above have been dealt with in previous chapters, this chapter will then turn attention to addressing some of the strategies used by the Energy Foundation in promoting end use efficiency in the electricity sector in the form of electrical appliance standards and the presentation of actual cases the demonstrate the saving potential of promoting electricity end use efficiency in Ghana.

5.3 Transformation through Energy Efficiency Standards and Labelling

Due to economic growth and improving standards of living residential and commercial electric power use continue to increase. Since 2000, Ghana has inproved her economic performance. Real GDP growth has increased from 3.7% in 2000 to 5.9% in 2005. This has led to more than a doubling of the growth of real GDP per capita—from 1.2 percent in 2000 to 3.2 percent in 2005 (International Monetary Fund, 2006). This growth has contributed to the increasing electricity

consumption particularly in the residential and commercial sectors of the country. This is great inprovements if we comapred that to a Africa sub regional growth of 3.5% to 4.9% per annum over the same period (Wilson, 2004). On the average the annual electricity growth in Ghana is 7% (Baiden, 2008), so without focused efforts to reduce the electric power consumption by appliances and equipment especially in residential and commercial buildings will mean a steady growth in energy consumption and that will affect the energy supply to the economy. This could lead to restraining economic growth and also other impacts such as on the environment. Therefore the need for an energy efficiency standards and labelling in promoting end use efficiency in residential and commercial sector in Ghana.

Energy efficiency standards*;*

"are procedures and regulations that prescribe the energy performance of manufactured products, sometimes prohibiting the sale of products that are less energy efficient than the minimum standard" (Wiel and McMahon, 2005).

The standards should prescribe the minimum energy performance, in other words the maximum energy use of an energy using product. On the other hand, an energy efficiency label attached to a manufacturing product indicates the product energy efficiency rating to provide consumers with the needed information in order to make an informed decision. It is one thing making the information available through the standards and labels and another thing for consumers to actually use it. For the labels and standard to actually have the needed positive impacts, consumers should be able to read and understand the lables. As already discuused in chapter four of the study, with large proportions of people in Ghana who are illiterate and cannot read and write the official national English language, there should be other means such as through scheduled and continous electronic media education in the local dialects to inform this group of consumers. So the current levels of literacy in the country somehow has a direct impact on how successfully we can harness the full theoretical benefits of using standards and labels to promote efficiency in the end use level. In this case, literacy as arguedin chapter four is a factor in promoting end use electricity efficiency.

Using energy efficiecy standards and labels can creat a stronger market for more energy efficient electricial products. Gradually replacing all low cost highly inefficienct electrical products

through standards and labels can subtantially reduce the electricity consumption in the residential and commercial sectors. This will later be demonstrated in the chapter with examples from residential and commercial sectors of Ghana. Applying standards and labels to phace-out inefficienct appliances take time and such phace-out duration or replace existing aplliance stock should be taking into consideration when enacting any standards. However, figure 5.1 below shows the overall long lasting positive impact of standards and labels as a means of promoting end use efficiency.

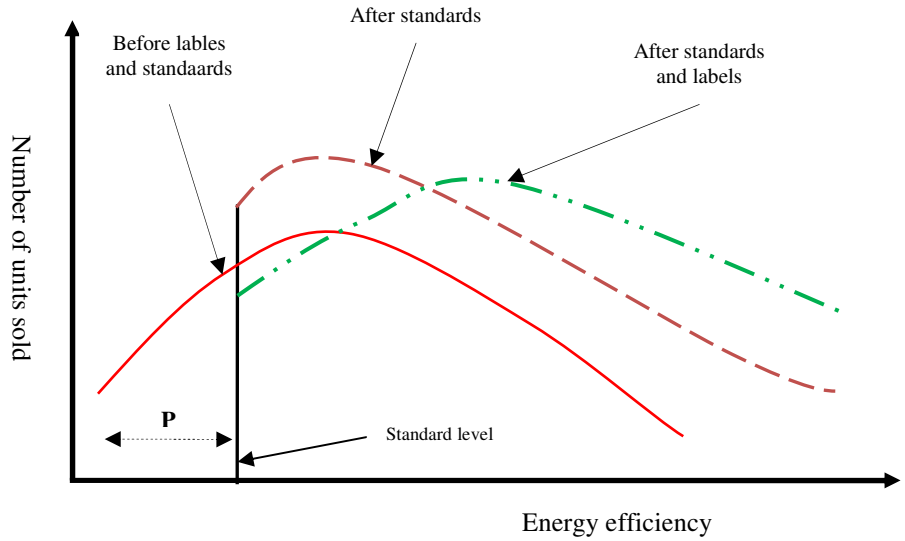

Figure 5.1 showing an illustration of the impact of energy efficient standards and labels on the market distribution of electrical products. Source inspired by Wiel and McMahon, 2005.

As illustrated in *figure 5.1*, the use of efficient standards and labels shift the distribution of energy-efficient models of products sold in the market upward *(indicated by the brown and green curves*) by eliminating the least efficient models. After the introduction of standards and labels there can be great improvements in the electric power efficiency of household aplliances *(indicated by green curve)*. Some experts estimate that as much as 10% – 20% developing countries consumption of electricity could be reduced with the adoption of comprehensive efficiency standards and appliance labelling, not even to mention the associated reduction in Greenhouse gas *(GHG)* emissions and other environmental hazards (Wiel and McMahon, 2005). But it will take a period of time (*indicated by P on the figure*) before the introduction of the standards and labels make any calculatable impacts on the energy consumption in the country and at the same time allow for inefficient ones out of the market *(phace out period).* This period of time is to alow enough

penetration of the efficient appliances into residential homes and offices. Determining what percentage of penetration of new appliances before they make an impact on the energy consumption is beyond the scope of the study. But there is a concensus that 10% penetration is will have an impact (Bernd, 2008). Again, how long and fast the period of new and efficient appliances saturation and also phace out of old and inefficient appliances depend on a number of factors such as the economic circumstances of consumers and their understanding, knowlegd and believe of how much they can save on the running cost by switching to new and efficient models.

Based on theorectical savings potentials by using efficient standard and labelling, the Energy Foundation of Ghana with collaboration with other institutions and agencies (*such as the Ghana Standard Board, Energy Commission of Ghana, Lawrence Berkeley National Laboratory University of California, etc*) in the early months of 1996 made the first attempt to draft and implement a minimum energy performance standard for electrical appliances including Room Air Conditioners (RAC) in the country. The programme Ghana Electrical Appliance Labelling and Standards Programme (GEALSP) was born.

5.3.1 Ghana Electrical Appliance Labelling and Standards Programme (GEALS P)

In June 2005, the Ghana Electrical Appliance Labelling and Standards (GEALS) became a mandatory standard in Ghana. The regulation applies to two end user appliances and these are; non-ducted air conditioners *(enacted 2002)* and self-ballasted fluorescent lamps *(enacted 2003)* manufactured in Ghana or imported for use in Ghana. These two standards are mandatory standards and under that importers of compact fluorescent lamps (CFLs) will be required to import and sell only products that meet minimum energy efficiency and performance standards approved by GSB. Furthermore appliance manufacturers and retailers are obliged to display a label which indicates the energy efficiency rating of the product before the first retail sale. The full standard and label requirements for non conducted room air conditioners and compact flurorescent lamps can be seen in the *appendix CD+B* of this report.

According to the Energy Commission of Ghana report on the programme, there were peculiar reasons why the GEALSP initially focused on few end use appliances. During the consideration for the standard and labelling one primary concern was how the coming into effect of standards

and labelling impact on the low income goups particularly refrigerators and other end use appliances such as television etc, which are considered as basic necessity and which have high market penetration and end use saturation. Initially, enforcing efficiency and labelling standards will increase purchase cost which might have adverse effects on poor consumers. Selecting room air conditioners as one of the first end use appliance to regulate and apply standards was reasonable in that, this appliance is basically used in affluent and commercial outfits which are in the position to afford any extra initial cost of such standards but surely to reap future lower cost of operating. During deliberations, it was realised that though the room air conditioners will not bring the highest overall savings in the country it will represent the least oppesed and that will give the opportunity to learn and improve on future standards for other end use appliances.

As mentioned in previous chapters of the report, the drought induces energy shortages in 1998 *(more recently in 2007)* facilitated the enacting of standards to regulate the use of lighting appliances in the country. Nearly 54% of the electricity consumption in urban population is used for lighting in Ghana (Keeneer and Banerjee, 2005b and Ministry of Energy Ghana, 2003 *official website*) mostly with highly inefficient incandescent lamps thus the effort to produce a standard and label that will ban the importation of all incandescent *(called onion bulbs in Ghana)* and gradually replace those existing in the country. Also given the market saturation of this electrical device and the fact that government of Ghana will initially replace almost six million and subsidise them will make any standard less controversial and easy to implement, (Anderson, 2007).

Ghana Electrical Appliance Labelling and Standards (GEALS) Requirements

The following are some brief descriptions of the requirements of the GEALS and for a full regulation and standard requirements readers are encourage seeing *appendix A* of the report. The following are direct quotations from the energy efficiency standards and labelling (non-ducted air conditioners and self-ballasted fluorescent lamps) regulations, 2005.

A. *Non-ducted air conditioners: "A non-ducted air conditioner manufactured or imported for use in Ghana shall in accordance with Ghana Standard 362:2001 have a minimum energy efficiency ratio of 2.8."*

Energy Efficiency Star Rating	Non-ducted air cooled 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

Table 5.1 showing Energy Efficiency Rating for Non Ducted air-conditioners. Source taken from GEALS regulation 2005.

Where EER is energy efficiency ratio meaning the ratio of the total cooling capacity to the effective power input in any given set of rating conditions

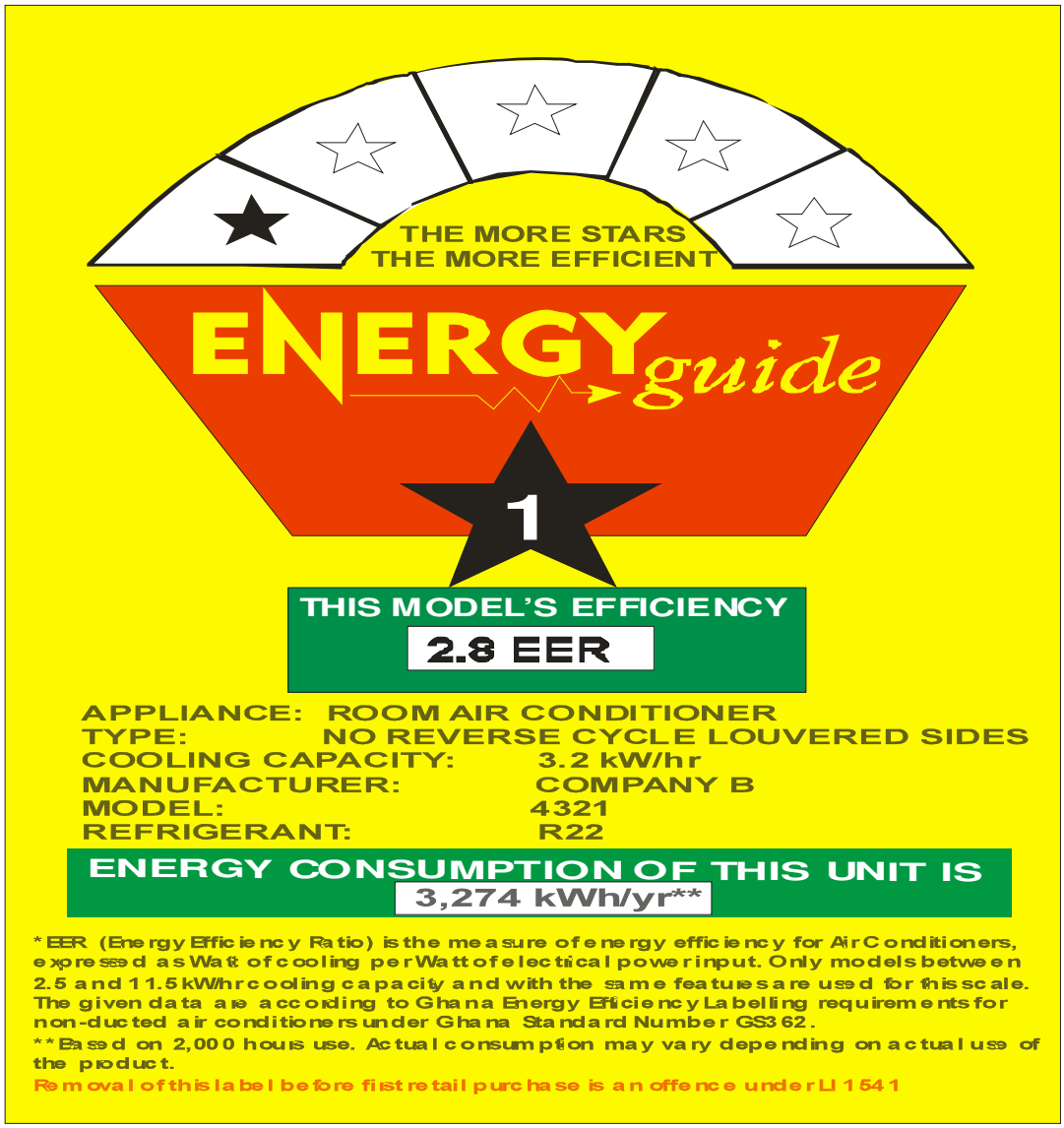

Figure 5.2 showing the efficiency label Rating for Non Ducted air-conditioners. Source taken from GEALS regulation 2005.

B. Self-ballasted fluorescent lamps

A self-ballasted fluorescent lamp manufactured or imported for use in Ghana shall in accordance with Ghana Standard GS 324:2003 have;

- *"a minimum rated life of six thousand hours*
- *a minimum efficacy measured in lumens per watt matching the lamp configuration (bare or covered with or without reflector) and lamp power (LP) rating as provided for in Schedule I."*

Lamps shall be classified as 5-star if:

$$W <= 0.24 \sqrt{\Phi} + 0.0103 \Phi$$

where
Φ is the lumen output of the lamp and W is the power input into the lamp in watts.

If a lamp is not classified as 5-star, a reference wattage W&subR; shall be calculated as follows:

$$W_R = 0.88 \sqrt{\Phi} + 0.049 \Phi, \text{ when } \Phi > 34 \text{ lumens}$$
$$0.2 \Phi, \text{ when } \Phi <= 34 \text{ lumens}$$

where Φ is the lumen output of the lamp.

The energy efficiency star rating are then set in accordance with the following table:

Energy efficiency class	Energy efficiency index E_1
4-star	$E_1 < 60\%$
3-star	$60\% <= E_1 < 80\%$
2-star	$80\% <= E_1 < 110\%$
1-star	$110\% <= E_1$

Table 5.2 showing the energy efficiency rating of compact fluorescent lamps. Source taken from GEALS regulation 2005.

Where W is the power input into the lamp in watts; and

$$E_1 = \frac{W}{W_R}$$

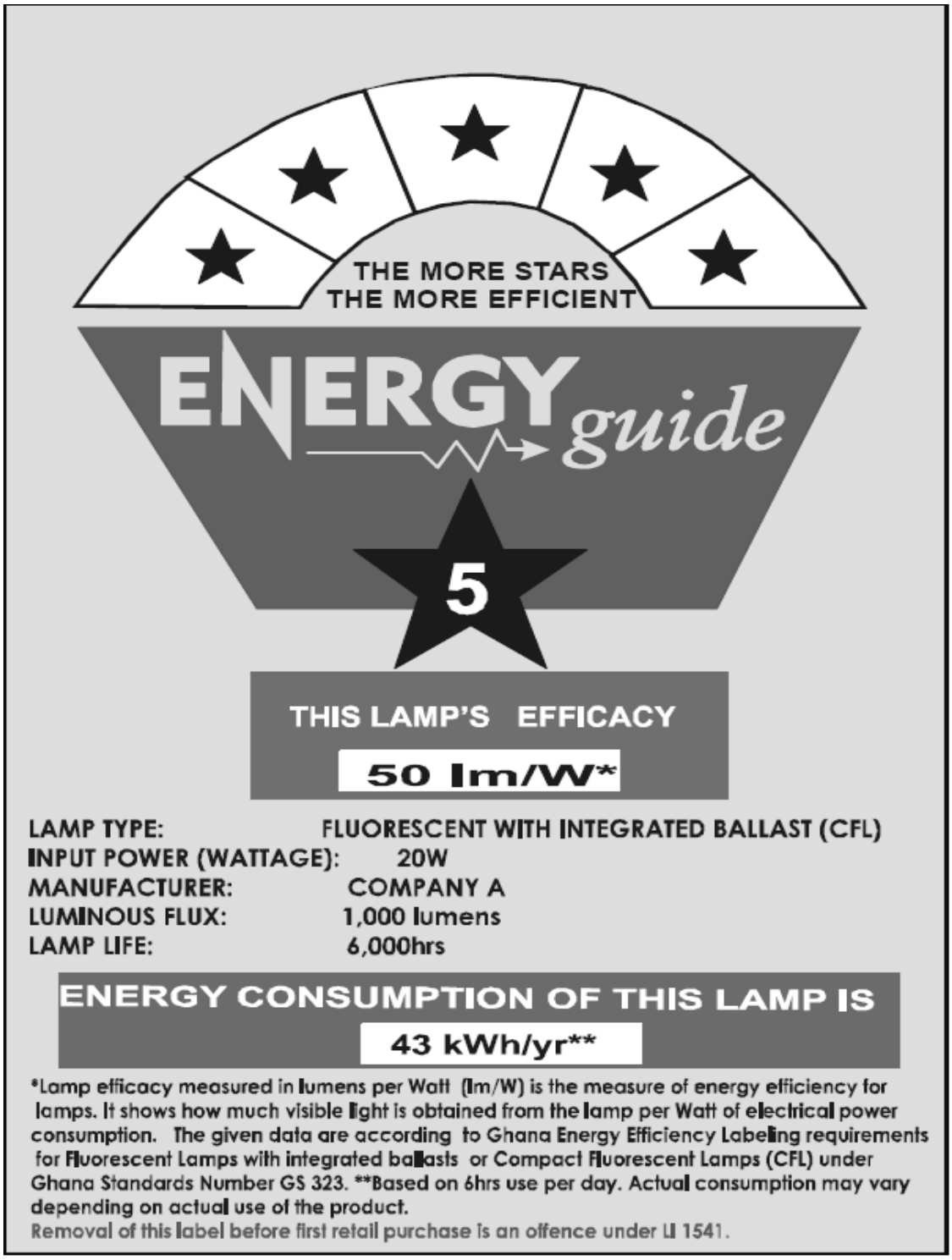

Figure 5.3 showing the efficiency label Rating for compact fluorescent lamps. Source taken from GEALS regulation 2005.

5.3.2 Saving potential of air conditioners and compact fluorescent lamps based on the GEALS

Room Air Conditioners	Compact Fluorescent Lamps
• Will save potential consumers an average of 64 US dollars annually in electricity bills. • Based on the new standards, room air conditioners will use 9% less electricity hence paying off any additional investment quickly. • Carbon dioxide emissions will be reduced by 2.8 million tonnes over a 30 year period. • Compliance with the new standards will free an average of 13MW of generating capacity and will save approximately 150MW by 2013 and 250MW by 2020. • Since these saving come from efficiency and conservation sources (*with air conditioners and lighting),* it will result in a net negative cost to the Ghanaian economy.	• This will save approximately124.2MW (207MW peak demand at a load factor of 60%), i.e 429,525MWh of electricity annually. • Carbon dioxide emissions will be reduced by 150,000 tonnes per annum. • 6million pieces of Compact Fluorescent lamps of various wattages 9W-20W that will consume a total of about 151.475GWh of electricity annually

Table 5.3 showing a summary of the energy and economic saving potential of the GEALS regulation. Source: Energy Commission of Ghana and Energy Foundation of Ghana official.

How Ghana stands to gain from replacing all incandescent lamps with compact fluorescent lamps.

This is just a simple calculation by the author to illustrate the extent of saving in energy consumption and in monetary terms by enforcing and replacing all the inefficient incandescent lamps in the country with efficient CFL ones. This calculation in no way is conclusive for it does not take into consideration the payback time for the investing in replacement exercise and others.

Assumptions:

- 5 million 80Wincandescent (IL) bulbs to be replaced by 5 million 40W CFL.
- CFL last 10 times longer than IC and use 4.5 less energy (Kemp, 2005)
- Lights will be used for 5 hours a day *(from 5pm to 11pm normarly in Ghana)*

5*7*4*12 = 1680 hr/yr

- Electricity price – 12US cent

Cost with incandescent lamps
Electricity consumption = 5*80W* 1680hr = 67,200,000,000kWh
Cost per yers = 672,000,000kWh * 0.12 = **USD 80,640,000**

Cost with CFL
Electricity consumption = 5*40W*1680hr = 336,000,000kWh
Cost per yers =336, 000,000 kWh *0.12 = **USD 40,320,000**

Total Electicity Svings = (672,000,000kWh - 336, 000,000 kWh)
= 336, 000,000 kWh/yr
Total cost savings = (USD 80,640,000 - USD 40,320,000) **= USD 40,320,000**

5.5 Electricity End Use Saving Potential in Ghana – The Case Study

Increasing trend of rural-urban migration*(these urban areas already have 100% access to grid electric power but does not mean every household or building is connected, Baiden, 2008)* and improving standards of living mean more people have access to electricity and increasing consumer electrical in the country which increase the demand for grid electricity in the country. Again, the Government policy of nationwide electrification projects including rural electrification projects adds to the strain on the demand for more electric power in the country. So the purpose of this sub heading is to provide an empirical data to show that saving potential of end use efficiency measures in the residential and commercial sectors.

Due to time resources constraints, the author could not conduct a first time survey and a case study on this but relies on a previous one conducted by the Energy Foundation of Ghana. The results of that study are used in this section to support the saving potentials of end use electricity in the residential and commercial buildings in Ghana. The data and some discussions are taken form the Energy Foundation official website; www. Ghanaef.org/publications./documents. With permission (*in a form of telephone request)* from the Energy Foundation, the cases are presented below. However detail discussion, analyses, results implications and the production of charts and figures based on the data are the done by the author.

There are two case presented, one for residential savings and the other for a commercial saving. For the purpose of simplicity and clarity, unnecessary details and information may be avoided.

5.5.1 Case Study for Residential Saving Potential

Case Study1 Background

This case study involves six selected residential households in the Ashanti region *(see geographical map of Ghana in chapter 4)* of the country. The type of residence was that of compound housing units in Ghana. The study involve two parts a) educating participants on various housekeeping measures to reduce their electricity consumption and b) the introduction and usage of compact fluorescent lamps *(CFL)* to replace all incandescent lamps *(onion bulbs)* in the various houses. The study lasted for eight months during which data for electricity consumption was monitored and taken. The eight months study was conducted in three stages.

- ***Stage 1:*** the usual electricity usage and consumption patterns were monitored without any comments for the first three months of the study duration
- ***Stage 2:*** after the first three months, the participants were educated on some ways to avoid using electricity inefficiently and basic housekeeping measures for the next two months.
- ***Stage 3:*** the last stage involve replacing all incandescent bulbs in the various residences with compact fluorescent lamps by the study team and electricity consumption patterns were monitored for the last three months of the study period.

Note: the monitoring of the electricity consumption was done through the normal metering system of the electricity company of Ghana (ECG).

Figure 5.4 showing CFL common on the Ghana market and these were used in the case study for residential electricity savings.

Case Study1 Results

The following tables and figures show the results of study of residential electricity end use savings.

Household	**Distribution of Lamp Type**		
	CFL	Incandescent	Total
A	3 = 50%	3 = 50%	6
B	1 = 25%	3 = 75%	4
C	3 = 37.5%	5 = 62.5%	8
D	3 = 75%	1 = 25%	4
E	1 = 17%	5 = 83%	6
F	0 = 0%	10 = 100%	10
Total			38

Table 5.4 showing the frequency distribution of lamps in selected household. Source: Energy Foundation of Ghana.

Household	**A**	**B**	**C**	**D**	**E**	**F**	**Total**
Consumption (average) *before* education kWh/month	164	67	433	242	225	390	1521
Consumption (average) *after* education. kWh/month	84	58	377	161	171	268	1119
Savings *after* education (%)	49%	14%	13%	33%	24%	31%	26%
Consumption (average) *after* CFL introduction kWh/month	43	37	303	89	No meter reading	198	670
Savings *after* CFL introduction on original consumption (%)	74%	45%	30%	63%	No meter reading	49%	52%

Table 5.5 showing the percentage electricity end use saving potential in selected residential households. Source: Energy Foundation of Ghana.

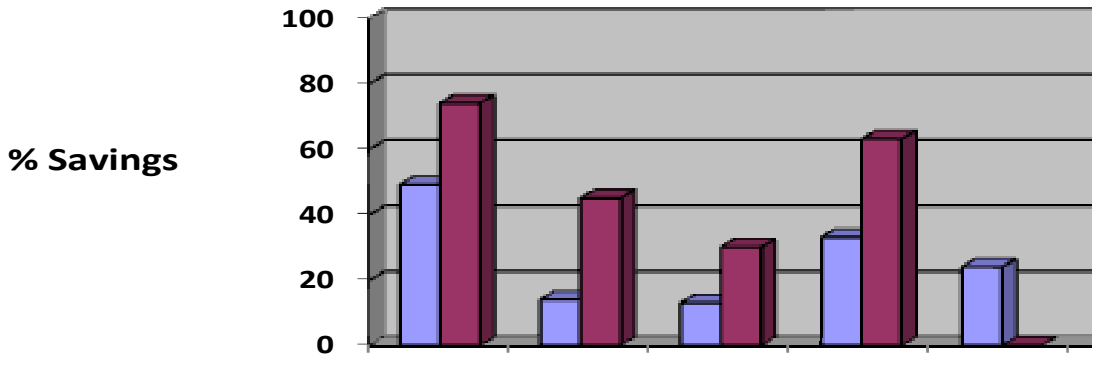

Figure 5.5 showing a comparison of savings in electricity end used efficiency measures through educations and CFL in case study one.

The percentage savings shown in figure 5.6 are not aggregate or compound saving and show seperat saving potentials with demand side management such as eduction and efficient appliance. Both show percentage savings over the original energy consumption of each household *(see figure legend).* Setting the two savings side by side, it is clear that the biggest savings come from the introduction of CFL. The least recorded savings was 30% compared to 13% for education and the biggest was impressive 74% compared 49% for education. There could be a number of reasons for these differences in the factor of savings with the two measures. Among them are:

- Households might have ignored some of the educational measures that were given to them.
- The same educational measures might not work for all the different householders in the experiment hence some householders might find some of the educational measures impractical or unhelpful.
- The replacement of all incandescent bulbs with CFL with will have impact across all householders *(though it might vary depending on the number replced).*
- After replace the lamps, the households may have little influence as to ignoring the basic measures compared to the educational one hence given the full impact of the CFL.

Summary of Results in Residential Savings Case Study

- Total electricity consumption of six households after they have been educated on electricity end use saving and other housekeeping techniques was reduced from 1521kWh per month to 1119kWh per month representing 26% *(see table 5.5)* improvements and saving of electricity at the end use.
- After the introduction of the compact fluorescent lamps, total electricity consumption for the six households reduced drastically from 1521kWh per month to only 670 kWh per month representing a 52% *(see table 5.5)* improvement and saving of end use electricity over the original consumption.
- Great improvement and saving potential in promoting end use efficiency in the residential sector. From the study, the savings ranges from 13% *(being the lowest recorded)* to the as high 52% *(being the highest recorded)* of improvements over the study period. This

means that, replacing all incandescent lamps in all houses in Ghana will greatly save some generation capacity or add to the generation capacity of the country and improve the "demand gap" in the electricity sector. The following simple calculation will demonstrate that.

5.5.2 Case Study for Commercial Saving Potential

Background Case Study 2

The second case inlvoles the offices of the headquarters of the Ministry of Energy in Ghana. As part of a strategy to reduce the national government recurrent expenditure such as utility cost, the ministry of energy embarked upon a project to eliminate waste, use electricity efficiently and reduce the overall energy consumption in its offices in Accra. Some basic measures were taken to achieve those objectives and these included

- Energy auditing and house keeping educational programmes: an energy auditing was conducted to establish the levels, which areas and the pattern of electricity consumption in the building. There was also education on simple house keeping measures such as switching off lights and office equipment when not needed or when the office is ancticipated to be vacant for a long period of time. Also drawing up of window curtains to avoid direct sunshine into the aircondition rooms.
- Replacement of higher higher higher wattage fluorescent lamps with lower wattage fluorescent lamps and lighting and airconditioner Passive Infrared sensors (PIR): fluorescent tube lights in the offices were reduced by 50% when a study conducted earlier proved that level can still provide the needed illumination in the offices. Also all 40W, 38mm diameter fluorescent tubes were replaced with 36W, 26mm diameter tubes. Also lighting and air conditioner sensors were installed because in was realised that (during the energy auditing), most often cleaners who prepare the offices leave the lighs on after cleaning from 6am to 8am before workers arrive for work. Again, some offices become vacant for long periods of time while the lights and air conditioners are still on. PIR sensors have the ability to turn off lights and air conditioners when the room is vacant for a predetermined period of time and turn on as soon as the room is occupied again.
- Building fabri improvements and arrangements: all lower level louvred windows were replaced with solid flush wooden panels in order to reduce high incidence of ventilation

heat gain in air conditioned rooms. The air conditioners were moved from the ground to a level 1.5m to 2m above the ground. The reason for this was to allow even circulation of cool air in the offices. This allowed using only one air conditioner instead of two to two for certain rooms.

Reaults of case study 2

The table below show the electricity consumption of the offices before those improvements were carried out.

	Annual consumption (kWh)	% of Total consumption
Lighting (internal & external)	55,910	23.5
Air conditioners	118,970	50
Office equipment	42,070	17.7
Others	21,150	8.8
TOTAL	**238100**	**100**

Table 5.6 total energy consumption by various end use appliances in the ministry of energy offices in Accra. Source: Energy Foundation of Ghana.

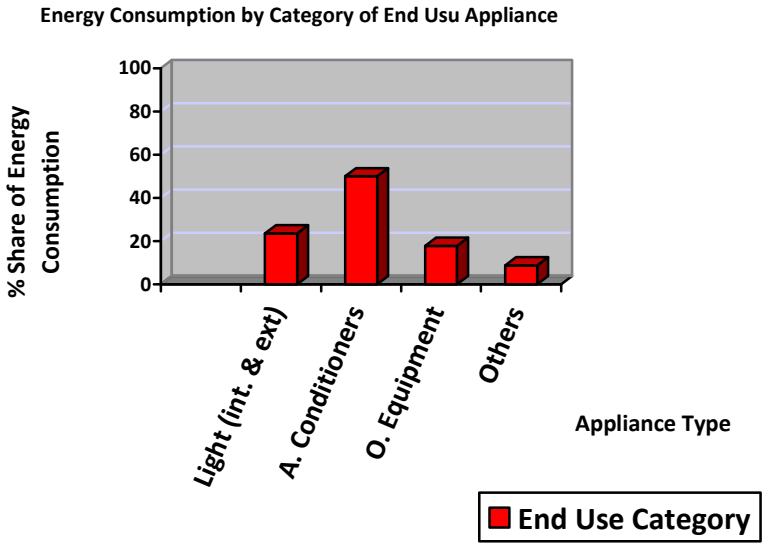

Figure 5.6 showing the electricity consumption by end use appliance type

After the various outlined measures were carried out for a year, the summary of the savings on all the measures is shown in table 5.7 below.

	Consumption before measures (kWh)	Consumption after measures (kWh)	% savings
Energy saving on all the measures taken	238,100	188,533	21

Table 5.7 showing a comparison between the energy consumption before and after end use efficiency measures

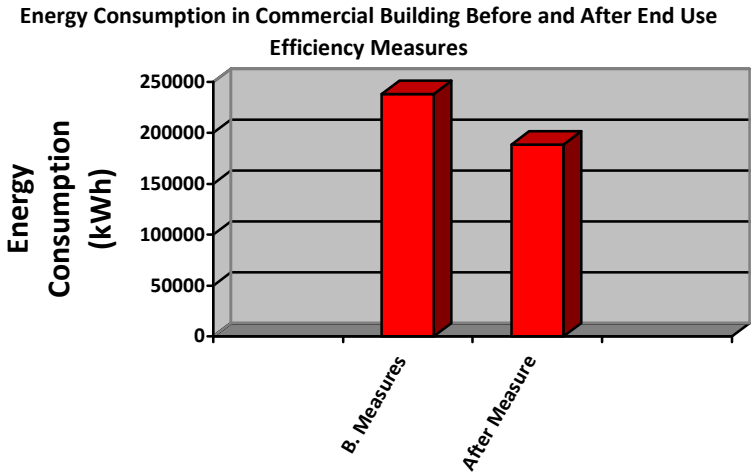

Figure 5.7 *showing a comparison between the energy consumption before and after end use efficiency measures*

The total saving from all the end use efficiency measures from simple house keeping (non cost measures) to replaces of lower wattage fluorescent tubes and lighting and air conditioner PIR sensors, nearly 50,000kwh of electricity was save representing a 21% savings. Figure 5.8 shows the comparison between the electricity consumption before and after the efficiency measures. In today US dollar equivalent terms, assuming the price of electricity in Ghana is 12 US cent that will mean an annual savings of (49.567 * 0.12) USD 5948.

5.5.3 Summary from Case Studies

The first case study showed a total of 52% savings in the electricity usage for the six households by replacing all the incandescent lamps in the houses. Assuming that at least 50% savings could be replicated countrywide *(this is possible given the homogeneous energy use patterns among urban dweller across the country)* then the country stands to gain much. Assuming replacing 5million 80W incandescent lamps with an energy efficient CFL with different wattages, the country can save (5*1680*80) = 672GWh of electricity.

The second case however did not record as big saving as the first case but it was reasonable to record a 21% decrease in energy consumption on commercial building end use electricity. The actually case may not necessarily represent a sample case for the commercial sector. The ministry's energy cost is catered for by the national government hence saving and utilising electricity will not be a first priority. However, a 21% saving replicated in the non governmental commercial sector will make more impact since private firms always find ways and means to reduce their recurrent cost including utility cost.

CHAPTER SIX

SURVEY STUDY AND ELECTRICITY END USE EFFICIENCY PROMOTION ANALYSES

Purpose: this chapter presents a survey conducted in Ghana during the study period. It also discusses and analyses the various issues raised in preceding chapters and how they relate and promote electricity end use efficiency in Ghana. During this discussion, the various challenges and obstacles in promoting and achieving end use efficiency in the residential and commercial sectors will be presented. The analysis will centre on two main areas as the key drivers in promoting end use efficiency. These are the electric power sector reforms through realistic tariff prices adjustments and electrical appliances market reforms.

6.1 Introduction

Some describe access to grid electricity as a "*leader and a follower*" for it pave the way and follow any major developmental agenda of every nation. Ghana´s grid electricity is characterised by inadequate supply in the face of increasing demand, high electricity wastage especially at the demand side not to mention the high distribution losses and lack of fresh capital investment in the electricity sector *(which is badly needed to revamp the generation and distribution setups).*

As already seen in *chapter 5,* the residential and commercial sectors hold promising improvement potentials and can save as much as 150MW of grid electricity (Energy Commission of Ghana) if the right policies and regulations are instituted country wide. The cost involve in pursuing end use efficiency could far be cheaper than investing and building new power plants *(this is seen in a context that, the capital and the environmental cost associated with saving 100MW of electricity will be cheaper than building a new power plant to generate this same capacity of power, Kemp, 2005).* Electricity end use efficiency can "instantly" free up load on the national grid hence make more generated electricity available for other users. However new power plants take some period of time before any useful generated power can be utilised not to even mention the associated environmental and capital cost.

6.2 Survey Case Study

The interview was conducted in Kumasi in Ghana during the first week of the month of June with consumers of grid electricity in the residential sector. It took three days from Monday the 2nd to Wednesday the 4th. The total number of respondents numbered 40 with two separate groups of 20 each of electricity consumers. The survey was carried out with consumers to ascertain their priorities and expectations with electricity supply in the country. Also, another objective was to establish the correlation between electricity use and efficiency measures based on economic and educational levels. Below is a brief description of the two groups that were surveyed. Members of each group of respondents were selected randomly though the author had a prior knowledge of where to find members of each group to meet the key objective of two groups with different levels of income and educational level of the survey. Each group of respondent were approached individually and the questionnaire read out *(at times interpreted into a local dialect for those with very low education who cannot read and understand English properly)* and the interviewer fills out the survey forms. This approach greatly improved the response rate and all those approached after explaining the purpose were willing to talk to the interviewer. That means there were 100% return rate and each respondent answered all the questions asked though on some few occasions some respondents were reluctant to reveal details about their income levels and whether they fall below or above the poverty line especially those who were within the low income bracket, i.e. group B. This though could be a weakness in the survey since such respondents may not reveal their true economic standing and educational level and this could hurt the final results of the survey. However though, it was this group of respondents who were easier to approach and less difficulty to interview.

6.2.1 Group A

This group was surveyed in Kumasi numbering 20. They are characterized with people with higher education, the least educational level was at a tertiary level and work in mostly the formal sectors *(as bankers, tutors, engineers)* of the country with the exception of 4 people who operate their own enterprise. All surveyed said they live in a rented flat and only share the amenities with their family members (*nuclear family average 5 including both parents, 3 people were singly parent family).* They all said they use the prepaid metering. This group tends to have

current knowledge about the electricity sector, like the various current reforms going on in the sector and some for the socio-economic implications for the country. Have pretty a substantial knowledge of various the institutions involved in the generation and distribution of electric power in the country. During the survey, it was very noticeable how majority of the respondent from this group expressed their dissatisfaction with the current power generation in the country but did not blame the national government solely for the problems in the sector. Unlike the other group, this group appears to earn a decent monthly salary *(above the minimum wage in Ghana)* and definitely live above the poverty line. Interestingly, there seems to be a common consensus among this group that electricity prices are affordable though they were quick to add that, for the ordinary Ghanaian who barely makes the minimum wage; it is a headache to afford the electricity bills.

6.2.2 Group B

This group was surveyed in an urban area, Kumasi *(the second largest city in Ghana) and number 20.* This group of people surveyed worked in the informal sector of the country and include food venders, public transport drivers, shop attendants, waiters etc. These are people who earn below the minimum wage and can be classified as low income earners but above the poverty line by Ghanaian standards. Due to this they are affected by any changes in electricity prices. All of them did not go beyond secondary school in their education and mostly source their information through the FM radio stations that use one of the Ghanaian local dialects. These people rent single in compound houses and live with their nuclear family with an average family size of 6 *(including both parents)*. They share the meter with other tenants in the house and pay the electricity bill by dividing according to the number of appliances use by each room in the compound house. Majority of this group have migrated from different rural areas in the country in the past to the urban center and trying as much as possible to make living very comfortable for themselves. One keen characteristic of this group is that, they seem not to know the institutions involve in the generation and distribution of electric power in the country and eager to blame the national government for any single problem in the electricity supply to them. During the survey, they openly and in a seemly angry tone express their dissatisfaction of the level of service provided by the electricity company and mistrust of the national government t solve the electricity problems in the country. Interesting though, they acknowledge the fact that,

the time has come for individual Ghanaians to play their little role in helping solve the countries various problems. And expressed the hope that they will always pay their electricity bill ones they are in a position to do so but added that most often they struggle paying electricity bill because of their fluctuating economic conditions.

The questions structure in the survey interviews were in general based on three simple focal objectives. These included;

- To establish general attitude of consumers to the consumption of electric power in the country and any attitudinal changes as a result of increases in electricity tariff.
- The pattern of electrical appliance purchase and the basic consideration of acquiring such appliances.
- Consumer's knowledge and awareness of end use efficiency measures and the motivations for doing so.

	GROUP A=20			GROUP B=20		
QUESTIONS	YES	NO	Others	YES	NO	Others
Awareness of electricity consumption per month	20	0	0	2	18	0
Affordability of electricity tariff	0	20	0	4	16	0
Electricity prices cheaper than other countries	2	6	12	3	12	3
Customer simply pay for inefficiencies of ECG	0	20	0	20	0	0
ECG done enough to educate on efficiency measures	0	19	1	2	18	0
Awareness of link between prices and conservation	18	2	0	0	19	1
Awareness of increases in electricity prices	0	20	0	5	14	1
Already conserving before electricity price increase	0	20	0	20	0	0
Willing to pay extra for improved services	2	18	0	20	0	0
Wastage of electricity at home or offices	18	2	0	0	20	0
Satisfied with current level of service by ECG	0	20	0	20	0	0
Do you use prepaid metering?	20	0	0	20	0	0
Prefrences between prepaid metering over old metering	20	0	0	18	0	2
Made changes due to high electricity prices	0	20	0	1	19	0
How important is saving of electricity	20	0	0	20	0	0
Reasons for saving electricity (Yes =saving money, No=help country, Other)	15	5	0	20	0	0
Dwelling type (Yes =coumpound, No =Flats, Other)	0	20	0	20	0	0
Income group (Yes =below poverty line, No = above poverty line, rich = Other)	0	20	0	0	20	0
Comparing electricity cost to monthly income (Yes=ok, No=expensive, Other)	15	5	0	20	0	0
How extra electricity cost is paid (Yes =onwed money, No=subsidy, Other)	20	0	0	20	0	0
Educational level (Yes=tertiary, No =up to secondary, Other)	20	0	0	0	20	0
Reduction of electrical aplliance because of tariff increase	0	20	0	0	20	0
Usage of CFL at homes	20	0	0	20	0	0
Number of electrical appliance usage (Yes = less than 5, No = more than 5, Other	0	20	0	20	0	0
Consideration of energy consumption of appliances before buying	4	16	0	0	20	0
Usage of alternative electricity source	0	20	0	0	20	0
Adopted method to save electricity at home (Yes = switch off light, No= nothing, Othe	20	0	0	17	3	0
Reasons for failing to pay electricity tariff (Yes = no money, No = dont want to pay)	20	0	0	20	0	0
Which institution to blame for electricity crisis in Ghana (Yes=government, No=ECG)	3	17	0	13	7	0
Moltivated by ECG activities to save electricity	0	20	0	0	20	0
Extent of knowledge about efficiency measures (Yes= average, No = not much, Other)	16	2	2	0	20	0
Purchase of appliances from "second hand" market	20	0	0	20	0	0

Table 6.1 below summaries the main findings from the survey

6.2.3 Summary of Findings from the Survey

- Generally, the results show emphatic decision making on the part of respondents. For instance, either great majority support or oppose when asked about something.

- Almost all surveyed expressed their dissatisfaction of the current levels electricity service provided in the country.
- There is a split on peoples willingness to pay extra for an improved services with a slight majority in favour of it *(22 – 18 split).*
- One biggest challenge in promoting end use efficiency is "behavioural" or "attitudinal" towards electricity saving. As 100% of all respondents *(from both groups)* confirmed they did not make any changes in their end use of electricity at home even with tariff increases. It is not surprising though as majority *(21 to 18, with majority in the lower education and income bracket group)* did not know the link between conserving and electricity cost or just have average knowledge about end use savings techniques.

It is worth mention that, the survey results in no way can be seen as *conclusive* on the issues raised in the questions due to the sample space *(only 40 people)* and the regional in balance of the survey. Also, due to limited number of questions used *(only 36 questions);* it might not reveal all the necessary data and information to make any conclusive results. However, the results of the data should be seen as an *indicative* pointing to what could be the facts and conclusions. The results of the survey are quoted intermittently in the analysis to support claims the author make in the report. For the full survey questionnaire and response, see Appendix B.

6.3 Electricity Sector Reforms and Institutions in Ghana – the Competitive Approach

With more than a decade of experience in electricity reform in Ghana, there is both an opportunity and a need to analyse the lessons learned and the way to improve the service delivery in the electricity sector in Ghana. This subheading is not exhaustive of all the fundamental issues of the various reforms that have taken place and how things should been implemented to reflect the needs of the sector but draws out some policy issues and the need for improvement in the electricity sector reforms.

We have already seen how before the 90s the electricity sector in Ghana was highly government driven, with all major utilities owned by the government, the absence of independent system regulators such as tariff setting and allowing private participation. The main objective was to extend electricity to all parts of the country and most of the utilities operated far below their

marginal production cost. This led to many utilities unable to cover cost of production and left them highly dependent on the national budget to cover the rest of operating cost and new capital investment for expansion. Most often, that needed state funding was not forth coming and that led to VRA and ECG undercapitalized and suffered supply shortages, deteriorating systems and system losses.

However, for Ghana to fully benefit from such sector reforms and improve the services from the electricity sector, some key characteristic and objectives should be pursued in addition to what have happened in the past.

A broader look at the sector reforms that have taken place as discussed in previous chapters show a ”private-investment” and economic growth as the main driven forces compared to ”competition, efficiency and choice”. Granted, state owned utilities need much needed private investment to increase capital inflows *(as the Ghana government has shown over and over again that, it lacked the single capacity to deliver all the capital inflow),* such efforts should be effected by deregulating the sector for other non state owned companies to enter the sector to generate competition. Without state owned utilities enjoying monopoly, they will compete and will be able to break-even if not make profit. Competition will then lead to more secure and efficient service by utility companies. With this utility companies will be able to march their long term marginal cost and promote supply side efficiency. On the other hand, consumers will be faced with choices because of competition and utilities will be forced to sit up to improve service in order to stay in operation. Some may argue that, such deregulation and competition will increase tariff for the final consumers. That might not be the case since the state object allowing such deregulation is to reduce price per unit cost and promote higher efficiency and increase national efficiency, such competition will be reasonably and fairly be controlled by the politically neutral policies. This will not only ensure low prices but that will again make it very attractive to private investors to invest in the sector. These were the key ingredients in many developed countries, e.g. in Denmark, the electricity market was liberalized in accordance with a decision of the Danish Parliament, “*the Folketing”*, in the mid 1990s. Generation and supply of electricity is subject to competition. There are a lot of private suppliers and producers of electricity in Denmark and consumers are free to exercise their choice of which supplier to use. However,

consumers who do not want to exercise this right will still be supplied with electricity with state own companies (Danish Energy Agency website, *accessed 17.06.08 and Olesen*). The electricity supply service in Denmark is stable and promotion of end use efficiency is part of the overall agenda of security of supply. For this reason 2øre is levied on the end user tariff price to promote end use efficiency measure .

In the survey conducted by the author, nearly 100% of the people surveyed expressed their dissatisfaction of the service of the utilities in Ghana most especially the distribution company ECG. The two serious electricity outages throughout the country experienced in Ghana for the past decade (in 1998 and 2007- Baiden, 2008) and large annual financial debts of Electricity Company of Ghana and VRA *(The debt profile of VRA amounts to over USD200 million as of August, 2007, according the Ghana news agency)* shows that the various ongoing sector reforms must be strengthened.

Granted, the electricity sector is one of the many sectors of Ghana´s economy but given the strategic importance of the sector to almost all other sectors, focusing on and eliminating other major bottlenecks such government interference for political interests, corruption and other malfeasance for should be addressed to make any electricity sector reforms based on competition work.

It must be mentioned that successfully embarking on competitive sector reforms in Ghana mostly depends on foreign capital (*Donor Agencies, China for Bui dam)* which often the country has less control of. There should be caution though, that national government cannot entirely leave the sector reforms in the hand market competition and should fairly intervene to provide a balanced cushion of the reforms. The national government can do that by protecting the most vulnerable in the country including those who fall within the poverty classification. That is why the government initiated programme of the "life line tariff" is commendable. Protecting the residential consumers especially from exploitation of any unfair tariff increases is important in a country where access and supply of grid electricity is perceived as a *"social good"* and a basic right where a consumer is entitled to.

In summary, pursuing the objectives of a successful electricity sector reform both in utility and institutional capacity should guided by four basic principles, these are;

- Increased competition and efficiency

- A wider choice for consumers,
- High security of energy supply,
- Protecting the environmental
- Low utility and cost effectiveness

6.4 Electricity Tariff Reforms and End Use Efficiency

A country faced with end use inefficiencies and struggling utilities to meet their marginal cost or production, it will be interesting to analyse how full long run marginal cost recovery *(LRMC)* through tariff increase could strengthen the utilities while ensuring an efficient use at the demand side. What this means is that, utilities will be able to meet their marginal cost of producing a unit of electricity with similar unit price to the consumer. Full Cost Recovery *(FCR)* as a strategy for promoting end use efficiency in Ghana has two sided advantage. First, it makes the utilities completive and attractive to investment and secondary it makes end users aware of the direct cost between end use inefficiencies and their electricity tariff charges. So it can be said that, full cost recovery by utility firms has a "top-down" and a "bottom-up" effects on efficiency in the electricity sector. Full cost recovery as a strategy to promote end use efficiency uses the basic principles price, demand and supply theory.

6.4.1 Price and Demand – the principle behind Full Cost Recovery and End Use Efficiency

In neoclassical economics, this relates to the individual's rationality and his or her ability to maximize utility or profit (Nordhaus and Paul 2001; Varian 1984). That is given the same level of marginal utility; an individual will choose the one that will satisfy his or her marginal utility the most at lesser price. With price as a determinant factor, an increase in price of a good (*in this case tariff*) will result in a reduction in demand of electricity use all things being equal. In a competitive market, price will function to equalize the quantity demanded by consumers, and the quantity supplied by producers, resulting in an economic equilibrium of price and quantity.

However, the demand and supply paradigm tends to change slightly in the power sectors. Most power plants with inflexible cost of production *(like huge hydro power plants due to high capital cost cannot stop production)*, so supply will be restricted and constant *(unless in periods of drought as in the case of Ghana, which might affect generation outputs).* So in reality, "in a

power system the supply always equals demand" (Bernd, 2008). This holds true for a sufficient electricity sector where there are no unmet demands. However, the case for Ghana with a demand gap where fluctuating and insufficient supply of electricity lead to quantity demanded far outwitting quantity that can be supplied at any time. Therefore, it is common to find power outages and rationing in the county to maintain this supply-demand equilibrium. So with increase in price, it is not possible for the power plants in Ghana to increase their supply in the short run *(but countries with excess installed capacity will be able to do so),* but maybe able to do so in the long run where high marginal cost returns gives the needed capital investment for expansion. Power plants in Ghana can use the demand gap reasoning to push tariff prices upwards in the short run for power supply increase in the long run. In Ghana´s situation where the actual quantity demanded will be more than the quantity supplied of electricity, it can be said that the quantity supplied of electricity supplied by the utilities in the short run is fixed supply.

The inflexible (*perfectly inelastic supply or fixed supply*) quantity of electricity supply (*in the short run*) and the demand gap in Ghana can be illustrated on the demand and supply diagram of the power system below. Note this is the authors illustration based on the inequalities in the quantity demanded and quantity supplied of electricity in the short and long run.

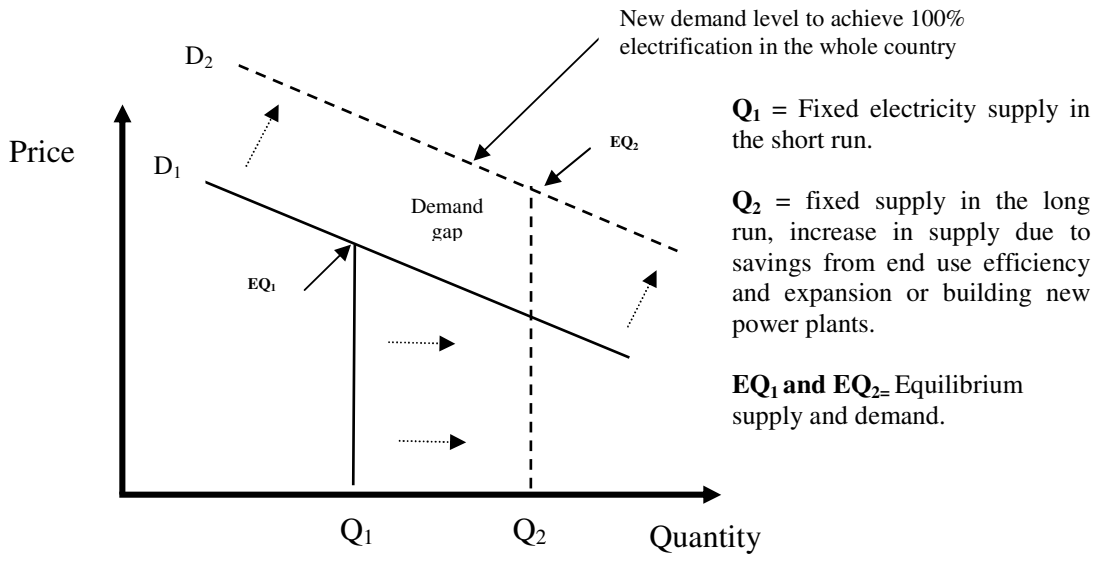

Figure 6.1 showing the authors illustration of the short and long term supply and demand for grid electricity in Ghana.

As quoted and mentioned earlier, based on Ghana´s installed capacity the supply and demand at a given price will be equal in the short run and is indicated on *figure 6.1* by the equilibrium supply and demand. However, increases in tariff prices as a reform strategy will push the price upward along the price axis (*y-axis).* This upward move in price might force consumers to adopt demand side management to reduce their energy consumption hence push demand down but note that the actual *quantity demanded* in the whole country will not decrease (*since there is quantity demand Gap).* Producers of electricity in the country should have responded to this increase in price with an increase in supply *(according to the neoclassical economics)* supply, however, since supply is fixed in the short term, utilities will only able to do so in the long run mainly due to two reasons. The first is that, saving accumulated through demand side management (*because of initial price increase*) and secondly, all factors of production are variable in the long run, the power generators will be meet their marginal cost and will be able to expand generation capacity through new power plants. Therefore, supply will move outwards from Q_1 to Q_2. Eventually though, the demand curve of electricity will move outward in the very long run from D_1 to D_2 because there will be a 100% electricification in the whole country both rural and urban areas.
EQ_1 is the first equilibrium point where the supply of electricity equals the demand in the country at a given price. However, due to tariff price adjustments and increase in the quantity supplied in the long run, there will be a new equilibrium point Q_2 (*higher than the Q_1 one with a higher new equilibrium price*) where supply will again equal demand in the power system in Ghana.

Though there have been price adjustment and increases as discussed in chapter 3 of the report, Ghana is still fall short of 25% of reaching full recovery cost (Baiden, 2008) and the huge debt deficits of the utilities especially VRA and ECG means that there will still be a "time gap" between ensuring supply side efficiency and quality of service and realistic tariff prices. That is for some period of time there will not be any substantial difference in the quality, efficiency and quantity of supply of grid electricity to consumers. But one thing that full cost recovery might ensure is "instant" rethinking of electricity usage at the end use level. As price and demand model predicts, increase in tariff prices will lead to a decrease in demand *(mainly due to end use electrical appliance management and switching to more efficient ones).*
The *figure 6.2* below shows the road towards full cost recovery in the electricity sector in Ghana.

Figure 6.2 shows electricity tariff prices from 1998 to 2007. Source: PURC.

In the figure it can be seen that the electricity tariff prices have been increasing since 1998 when the first public electricity adjustment was made by the newly instituted PURC. The End Use Tariff (EUT-yellow line) in particular has been increasing since 2000. The quoted prices are in real terms, that is they inflation adjusted. The figure shows a big variation in the utility price for year 2000 and this was mainly due a big depreciation of the Ghanaian local currency *(the cedi)* against the US dollar. In 2000 the local currency depreciated 60% against the US dollar adversely affecting the utility tariffs *(tariff are priced and quoted in US cent equivalent)* and international trade (www.findarticles.com, accessed 21.06.08). These increases were as result of the PURC tariff review in every four years as mandated by the Act of Parliament setting it up. While electricity tariff is yet to reflect full economic cost of production, the utility companies especially VRA and ECG have welcome those increase and have even pushed for faster and higher increases than what happened (Baiden, 2008). Currently, the final price of a unit of electricity for a residential consumer is around 12 -13 US cent compared to 35US cent in Denmark. *(Please note that these prices include VAT and other levies in both countries).*

The figures below show the electricity and billing charges components in Ghana and Denmark.

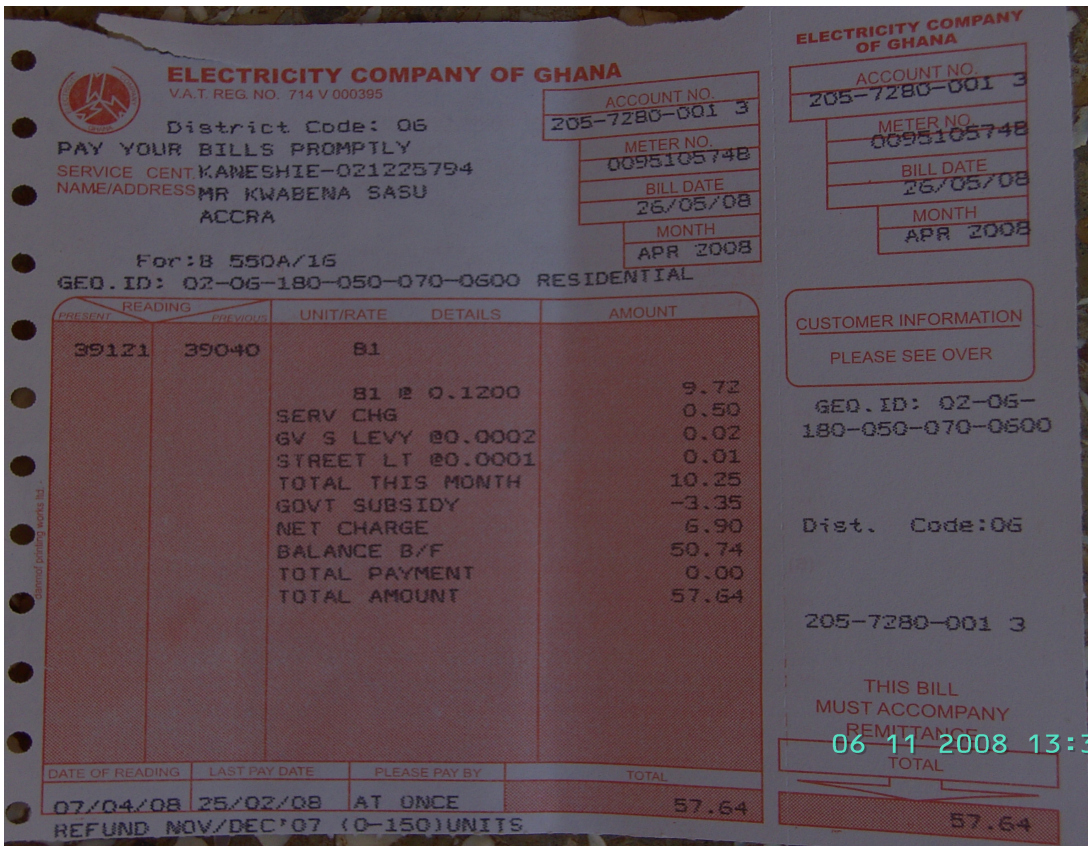

Figure 6.3 showing the monthly electricity bill from ECG in Ghana.

A closer look at the residential electricity bill reveals the following:

- The end user tariff is currently at 0.1200 new Ghana cedi
- Some components of the tariff charges
- Government subsidy (for customer whose monthly usage is 0-150kWh)
- At the bottom of the bill shows that the customer falls under the second category of life line customers (*more than 50kWh but less than 150kWh per month – see under chapter 4)* tariff qualified for the government subsidy of almost 30% as shown on the bill (-3.35). Remember that, life line customers whose consumption falls between 0-50kWh per month enjoy a double government subsidy and those of the second category 51-150kWh per month enjoy only a single government subsidy.

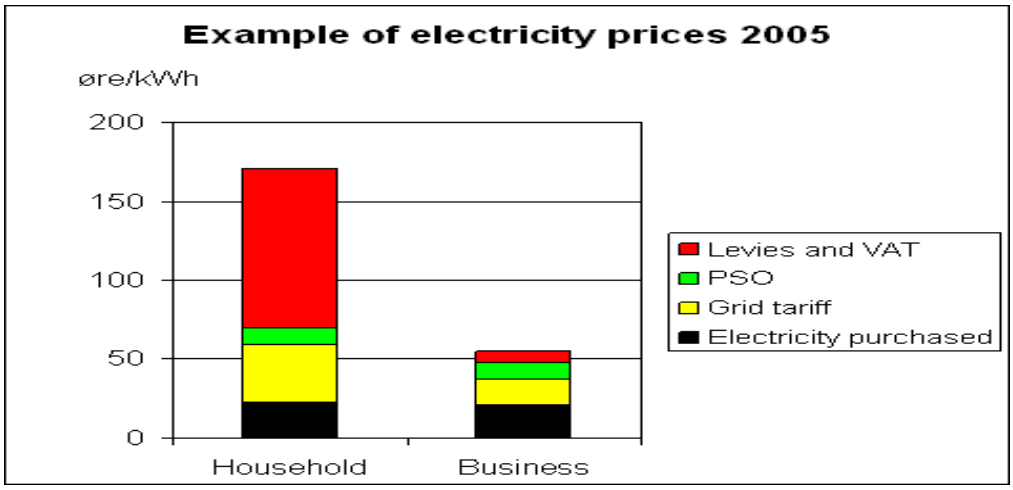

Figure 6.4 showing components of electricity End User Tariff in Denmark. Source: Danish Energy Agency. Accessed 18.06.08.

Ghana	**Denmark**
Levies (street light, national health insurance)	Levies
VAT (17%)	VAT (25%)
Bulk Service Tariff (BST)	Public Service Obligation (PSO)
Distribution Service Charge (DSC)	Grid Tariff
End User Tariff (EUT)	Electricity Purchased

Table 6.2 shows a comparison between the components of end user electricity tariff in the residential sector of Ghana and Denmark.

Table 6.2 simply want to draw a parallel between the component of end user tariff in Ghana and Denmark. To do a complete comparison and analysis of the tariff structure and economic implication of the two countries will require comparing the income structure and levels *(standard of living)*, electric sector performance etc which is beyond the scope of the study.

Perhaps the greatest strength of using full cost recovery *(utilities meeting their long run marginal cost)* as a tool in pursuing end use efficiency is that, it leaves the choice of using electricity efficiently at homes, offices and all other places with the final consumer. The principle it straightforward, *"use electricity wisely and efficiently and save on your utility cost"*. Full cost recovery tariff will ensure that if you are not using power efficiently then it will reflect in your electricity bill. Probably this will ensure that some people may have to put off one of their

refrigerators in order to reduce their energy consumption due to high tariff price. Also that will make people improve on their building fabric to improve its energy efficiency like putting wood panelling in a room before you put an air condition in the room (Baiden, 2008) so as to improve the insulation of the room. This will ensure any unwanted and unnecessary demand can be removed for productive use.

Interestingly there are those who use power inefficiently and claim they have the money to pay for it. This implies that, not all individual residential consumers will act rationally in maximising their marginal utility as neoclassical economists claim. This means, not all end users of electric power will maximise their marginal utility as a result of any tariff price increases. This group of residential users can be contrasted with end users in the commercial and industrial sectors who as profit oriented businesses will always maximise profit levels through marginal cost maximisation. It can be said that, the commercial and industrial sectors will certainly respond to any tariff price increase by finding ways and means to reduce their energy consumption cost. For end users in the residential sector who will not act rationally to maximise their marginal utility, measures such as education can appeal to such ones that, knowing wasting electricity is also a "moral issue" because wilfully wasting electricity denies another person from having access or enough electricity to use. The lessons of the 1997 energy crisis show how each and every final residential or commercial end user of power has a responsibility to save electricity, because the problem of power outages and rationing affects all without exception.

In all these there should be a balance in ensuring that customers pay full cost recovery and also the utility are performing. That balance is the legislative responsibility of the two main regulatory bodies in Ghana, the PURC and the Energy Commission. One of the main failings of electricity tariff reforms reform has been a lack of emphasis on service (Williams and Ghanadan, 2006). In many developing countries like Ghana, service improvement has not been proportionate with tariff increases. In the survey conducted during this research in Ghana, 39 out of 40 people surveyed during the study period believed there has not been a corresponding service improvement in the electricity sector with all the tariff prices increase from the past. In as much as this survey is not conclusive on electricity service quality and past tariff increases, it reflects concerns that should be taken into consideration when promoting end use efficiency through realistic tariff pricing. With only a price increases targets without paying much attention

to consumer concerns will result in loss of public support for any implementation of realistic tariff reform. However, electric power services that balance full cost recovery with considerable improvements in electricity access, quality of delivery and affordability needs to be the goal as the basis of sound commercial operation in the sector. One approach is to incorporate performance based tariff that any tariff increase will reflect in the service provided by the utility companies.

However, when it comes to willingness to pay for extra electricity tariff charges for an improved and quality service delivery by the utility company there seems to be a split among the same group of people. With 55% of respondents are in favour while 45% are against such price increase. This means that in as much as consumers especially groups and individual consumer association in the residential and commercial sectors may oppose to tariff reforms in the form of price increases, they are willing to pay extra if they can match a clear corresponding improvement in the services provided by the utilities.

Even when the utilities fail to improve service for some unknown reasons after tariff price increases, "consumer pressure" through the national government will do that to some extent. Consumers can lobby and threatened the government by demanding service improvement or they will vote against them in the next general election (*the pressure will be more meaningful when that year is a presidential election year or close to it).* The regulatory bodies that are in charge of the tariff setting especially the PURC though suppose to be "independent" and autonomous body still can be influenced to a great extent by the national government. The "consumer pressure" through the national government will start a "bottom-up" agitation that will demand and help push for quality service delivery and supply end efficiency on the part of the utilities.

6.5 Electrical Appliance Market Reforms and End Use Efficiency

Approximately 51% Ghana´s electricity use is consumed in the residential and commercials sectors of the country. with this comes the increase in the use of electrical appliances mainly use in the residential and commercial sector such as lighting, refrigerators-freezers, stereo, television, electric fans, air conditioners, computers, fax, photocopiers and scanners, printers, etc. The Ghanaian market for these appliances in diverse, comprising of brand new and used appliances mainly imported into the country from developed and transitional countries in Europe, North

America and Asia. The "second hand market" by far forms the largest and is often characterised by inefficient appliances which have been imported by local dealers into the country or dumped by developed nation. It is worth mentioning that, even not all the brand new electrical appliances found in Ghana are of the highest efficiency standards compared to similar brands and models in the OCED markets.

It is not uncommon to find greater proportion of the Ghanaian population patronising the "second hand market". In the survey conducted, 39 out of 40 people surveyed confirm they have purchased either more than half or all of their current electrical appliances from a second hand market. Almost all, 99% of those surveyed had around 5 different electrical appliances they currently use at home.
Improved economic conditions in Ghana may lead to acquiring more and new electrical appliance whereas in many OCED countries today, demand in new electrical appliance is mainly driven by replacing old appliances with more efficient and quality products on the market (Steenblik et al, 2006).

The "second hand market" for electrical appliances in Ghana is highly unregulated, small scale retailers, diverse and can be found nationwide especially in the urban areas of the country (Accra and Kumasi, etc). Unregulated second hand electrical appliances can have significant impact on any end use efficiency promoting measures and even affect the peak load demand of the electricity sector. For example, a modern refrigerator-freezer found in most OCED countries today will have an average consumption 500 – 550kWh per year compared to an inefficient to 1200-1800kWh per year that may be found on the second hand market in Ghana (Steenblik et al, 2006). The differences in energy consumptions of the two appliances demonstrate how much savings exit by ensuring a drastic change in the appliance purchase market. The choice is obvious; *to successfully promote electricity end use efficiency in the residential and commercial sectors in the Ghana, the "second hand market" for electrical appliances should be monitored and regulated.*

Already in *chapter 5*, we have discussed how simple mandatory standards and labeling can ensure energy end use efficiency. The mandatory standard in Ghana bans the importation and

selling of any electrical appliance that do not meet the requirements. However there exit a "performance gap" in enforcing these standards due to weak institutional capacity and port controls a problem also seen in all institutional setup in the country. In the developed world, government can easily regulate the sales of inefficient electrical appliances through the market *(manufacturing and shops – sales outlet)* but that seems difficult if not impossible in Ghana because of the nature and characteristics of the electrical appliances market described above.

Ensuring a market saturated with efficient end use appliances in Ghana though possible in a future development perspective but currently is constrained by poor economic conditions *(poverty).* Nearly all people survey acknowledged that they do not consider the energy consumption of electrical appliances before buying them. For them their first priority is the affordability and functionality. In Ghana is quiet difficult to distinguish between those that purchase from the second hand market and those that buy brand new ones but the scale tilts against those in the lower and middle income brackets.

Since it is difficult regulate the "second hand market" for end use electrical appliance in Ghana the model of using "electricity tariff pricing" as a deterrent from purchasing efficient end use electrical appliance will seem even more appreciated. This approach may hurt some consumers who patronize a very diverse market of used appliances however; investing in efficient end use electrical appliances can typically be viewed as involving a "trade off" between higher initial purchase price for new and efficient appliances and lower operating expenses for incremental increases in energy performance. With this education consumers will be faced with a choice. To a large extent many Ghanaian consumers consistently make investments in energy consuming products with heavy focus on the purchase price and little attention to subsequent energy cost of inefficient over the operating life of the product mainly due to lack of capital and cash flow problems. They look at the "first cost" rather than the "life cycle cost". In effect they undervalue the savings associated with efficiency.

CHAPTER SEVEN

FINDINGS AND CONCLUSIONS

Purpose: this lasr section presents the conclusiom(s) and the findings of the study and make on on the research problem and the related questions the author raised at the onset of the study.

The study established two key issues with Ghana's electricity consumption. The first is that, Ghana is faced with quantity demand and supply gap, ie insufficient electricity generation capacity to meet nationwide demand. And the second is that the country is comfronted with inefficiencies in both the supply and demand side of electric power generation.

This study set out to analyse and answer the question "To what extent can energy end use efficiency in the residential and commercial buildings sectors in Ghana positively contribute to the electricity demands in Ghana and what are the main obstacles in promoting electricity end use efficiency in this sector?"

To give the ultimate answer to this question however, the author will be guided by the other research question also asked the commencement of the report.

The history of power generation has been the major responsibility of the national government. During the study, it was realized that the institutional structure of the electric power sector in Ghana can best be described as a vertical flow setup with the national government through some public companies such as the Volta River Authority incorporated, the Ghana Grid Company, the Electricity Company of Ghana etc generates, transmit and distributes power in the country. These are the very institutions mandated to ensure adequate, reliable supply and promote electricity efficiency in the country. However, years of underperforming due to inbalances in their marginal cost of production and subsidized electricity tariff prices have rendered these institutions uncompetitive. Sector reforms in the mid 80s and throughout the 90s failed to liberalize the electric power sector market because they were focused on only removing subsidies and not on performance based tariff reforms.

The electricity sector is just only one of the many sectors of the economy; hence it competes and interrelates closely with other sectors of the economy. As the study revealed, any "theortically"

good and well formulated policies for promoting efficiency in the end use sector could fail to achieve the desired results to the poor economic and educational country in the country. Therefore, promoting end use efficiency measures should correlate with improvements in the other sectors of the country.

Residential and commercial building electricity usage holds great potentials for saving and freeing up some generated capacity without necessary investing huge capital. As was demonstrated by the residential case study, simple training and educating residential electricity users could save as much 30% on the energy consumption of lathing in the residential sector. The case studies demonstrated that, educating and vigorously enforcing minimum standards and label to phace out all inefficient electrical appliances such as incanscent bulb, room airconditioners in the residential and commercial sectors could save as much as 52% and 21% respectively of the energy usage in these two sectors.

With all the possible potential savings in pursuing demand side management measures in the residential and commercial building sectors of the country, there are still some major challenges that must be overcome. Principally among them are the entrenched behavioural towards end use efficiency, successfully regulating the second hand market which provide readily available, cheap and inefficient electrical appliances. The study revealed that, there are no social distintions between those who patronize the second hand electrical products. Years of neglect of the individuall consumers in the decision making has given rise to strong apathy towards government initiated programmes and this must be overcome if end users are be convinced that they too stand to gain from accepting and adopting end use efficiency. The “bottom up” research strategy through consumer survey confirmed this as a problem as consumers were quick and easily directed every single problem towards the government *(They somehow right; who else to blame).*

Lastly another key obstacle facing the sector help hampering demand side manament measures is investment shortages in utility companies. For one thing, end use efficiency will be given the needed boost if it becomes one of the main focal point of generating and distribution companies and motivate final consumers to adopt. Lack of the needed capital investment make utilities focus on their production activies by trying to stay afloat and stay in production.

To conclude on the formulated problem, the report showed that there pursuing electricity end use efficiency in the residential and commercial sectors in Ghana holds interesting possibilities of adding to the electricity demands in the country by adding to the grid the saved otherwise would been wasted electricity with no environmental cost to the nation. However, demand side managent can only work to an extent, no matter the levels of demand side measures Ghana pursues, we will still need electric power to operate "our efficient" end user appliance. This means that, demand side management should used and adopted together with other measures to ensure Ghana achieves her goals of becoming a middle income country by 2020.

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APPENDIXES

APPENDIXES

APPENDIX A

INTERVIEW CONDUCTED WITH BAIDEN OF ELECTRICITY CORPORATION OF GHANA ON 25.05.08

Q1. What is your understanding of electricity end use efficiency?

ANS. For a distribution company like ECG, when talking about electricity end use efficiency of power, that means the using power to maximize the needed benefit through any activity you are doing you maximize power to get more needed befit from it. Example, let's say you are at home and you have several electrical appliances you are not using on, when you switch off the appliances you are not using, here you are using power in a more efficient way. It has to do with demand side economics or demand side of power. In Ghana what is going on is replacing all incandescent bulbs with more energy efficient once to reduce power consumption just to reduce the active component of power. A typical example of a reactive and active component of power is like the foamy part of beer and the drink itself. To generate power you need both of them. The reactive component of power has no value, it goes as waste and the active component is what the consumer uses. The incandescent bulbs (the onion bulbs) takes more reactive power so that the system operator or let's say the generation company will have to put in more reactive power to supply consumers but if consumers use more efficient appliances then it will take less active power so the generation company doesn't need to invest more in such equipment to keep the system running because whatever the consumer does feeds back into the distribution system which in turn feeds back into the generation system. So in summery electricity end use efficiency is what happens at the final end of the electricity supply chain, i.e. at the final consumers end.

Q2. What is the electricity structure in Ghana in terms of policy formulation?

ANS. For policy wise, since all the key players in the energy sector are owned by the government. If I talk about the key players, I mean the generator, the transmitter and the distributor; all these institutions are owned by the government do the government sets out the broad policy framework. Then the utilities will operate within that framework. Example, in terms of electricity pricing or rate setting the government will say I want to subsidize the poor or make electricity affordable to the general public so the government will say from 0 – 150kWh I am going to subsidize it so if the distribution company is designing a price frame then it will factor in the government subsidy framework into it.

Q3. Does the government do through parliament since we operate that in Ghana?

ANS. Yes some through parliament i.e. through a legislative instrument. Government sets up a technical and regulative body like the energy commission, they are responsible for the technical guidelines in the energy sector then there a commercial regulator or the economic regulator which is the Public Utility Regulatory Commission (PURC) which is responsible that tariffs cost reflective or meet economic cost of production. Is not only legislative instrument some come through the ministry of finance but the main ones will have to go through parliament approval like street lighting levy, the rate which is currently being charged comes from a legislative instrument.

Q4. How do the utilities push their policy through for implementation?

ANS. What happens is that government will appoint the managing director lets say the electricity company of Ghana and then the same government will appoint board of directors to the company. Now whatever decision the company makes will be subject to the approval of the board of directors before it comes into being. If they want to do any major project or if they want to utilize any major technology, it has to gets the board of directors approval before it comes into being. There is a similar arrangement for the other utilities ie the top management is appointed by government.

Q5. Do the utilities in Ghana profit oriented companies or just to break even?
ANS. For a government owned firm, electricity is considered a social commodity or good, so once an individual applies for electricity you are obliged to supply power to the customer at all cost whether it is lucrative or not. So ECG as an entity, what PURC does is that, they make sure the utilities break even, they don't make profit and if there is any short fall then the government tries to provide that to bridge the gap in times past. And there are no private firms though is now that we are trying to open the market because we had the energy crisis so we brought in a number of private owned firms who are now going to set up their own businesses and generates power in different parts of the country. But currently what are existing are government owned.
Q6. How much does it cost to produce a unit of electricity and how much do we pay compared to other sub Saharan African countries and the world (kWh)?

ANS. We have a generation company which is the Volta River Authority (VRA – Akosombo hydro plant, Kpong Hydro plant and a thermal component in Takoradi called the TAPCO and then TICO – Takoradi International Company) and transmission company which is the Ghana Grid Company (GRIDCO) which a breakaway company from VRA and a distribution company (which is the electricity company of Ghana responsible for the southern sector of Ghana and the Northern Electricity Department which is responsible for the northern part of the country), so there is only two distribution companies all owned by the government. When Ghana went into the energy crisis there came some Emergency Power Producers (EPPs) and supported the generation with more thermal generation. And now as a long terms measure, there are IPPs Independent Power Producers. Currently ECG has signed a power purchase with about six of them who are expected to start construction and assembling their plants and start production. Now with the prices, VRA will come up with a Bulk Generation Charge, GRDCO will come up with a transmission service charge, and then the distribution companies which is ECG and NED will come up with a distribution service charge so that what goes to the customer which is the End User Tariff is made up of the Bulk Generation Charge (BGC), the Transmission Service Charge (TSC) and then a Distribution Service Charge (DSC). All together is passed onto the customer meanwhile each component goes to a different entity. Added to this final charge to the consumer is a value added tax (VAT), a national health insurance levy and a street light levy. And currently the End USER tariff charge is 12.77 new Ghana pesewa or 1277 old Ghana cedi. And this price doesn't reflect the economic price or rate. And this current rate is 75% of economic rate in Ghana. When you talk of economic rate, it has to do with full cost recovery tariff and currently VRA and ECG are not operating at full cost recovery and still operating at losses because their full cost is not passing onto final consumers. Compared to some countries in the sub region, Ghana has one of the lowest rates of tariff. Recently we met with some Kenyans, Tanzanians and Ugandans and they pay in the region of 24 US cent which is very high so I think within the sub region we are one of the cheapest.

Q7 what is the regional distribution and the rural - urban in the country?
ANS: The largest consumer is Accra the capital followed by Tema and then Ashanti, Eastern and so on in that order. ECG has its own regional division. Electrification in Ghana is about 54%, i.e. 54% of the population has access to grid electrification in Ghana. And there is 100% access to electricity in the urban areas of the country. And in the rural areas we are trying to expand with self help electrification project.
Q8. Please, what are the self help electrification project and the life line tariff in Ghana?
ANS. The self help electrification, what we call SHEP is like rural communities without access to electric power, so they come together with their opinion leaders to contribute, let say buy some poles and provide labour and apply for electricity at ECG for power, then ECG or the ministry or the government of Ghana or ECG will generate some internal funds to provide power to them. Then just a token is charged by ECG to connect them to the national grid, then within the first 2 years, they are charged with 5000 Ghana cedis, that is the cost of providing power and then meters are installed for

them. In recent times the Chinese and the European Union have come to provide financial support to this SHEP project to provide power to a lot of rural customers.

With the life line tariffs, customers from 0-50units of power per month are given a double subsidy from the Ghana government and those from 51- 150 units per month are given a single subsidy by the government. What this means is that the first group benefit from a 6000 Ghana cedi reimbursement, i.e. government gives 6000 Ghana cedi to everyone that consumes less than 50units a month and then the second subsidy is that consumers are suppose to pay 787 Ghana cedis for every unit of electricity consumed but government but government will subsidies that to 583 Ghana cedis and the rest I will pay. But those that consume more than 51 units will only benefit from the second subsidy. Initially it was only for consumers who consume 0-50 units but government intervened and increased it to a 50 units per month. The main criterion is only based on the consumption per month and nothing else. It is for all customers to matter your economic status. The main objective of this provision is to support all forms of workers especially the low and middle income group of workers and in so doing they cover majority of the rural dwellers and also the urban poor. For those who have money to pay, government will not want to subsidies to pay for them that are why it is set at 150 units per month. Since there is no accurate data base on income levels in Ghana, in a way it is assume that those that fall within the low and middle income groups in Ghana will not consume more than 150 units a month hence the life line tariff will be able to meet its targets. So for a rich income home with say, TV, HI-FI system, refrigerator, air condition etc, these are household whose consumption wills more than 150 units a months and these households will be able to afford the tariff and government wouldn't want to support these. So this is a rough way to determine who is rich and who is poor.

Q9. Do think there is a tendency for though a poor person because he is using inefficiency appliances to consume more than the 50 units or 150 units per month?

ANS. For a poor person, is likely to use inefficient appliances but he will not be able to buy large electrical gadgets. However they tend to use incandescent bulbs (the onion bulbs) but will not acquire large and plenty electrical appliances. The only problem here is the compound house effect where a lot of people will go and rest rooms in a single house and then share only one meter and because of the nature of tariff for such house (block tariff), so is likely such a household will be moved to a higher consumption category for them to pay more, so those in the compound houses, there is the tendency for a poor person to pay higher tariffs. ECG is trying to solve that problem by providing more meters to for all those who want individual separate meters.

Q10. How do you deal with a life line customer whose consumptions fluctuate on monthly basis?

ANS. For a credit metering customer, we will be able to determine that because at end of the month the metering reading will show. For a prepaid customer if you exceed the 50 units, he or she will lose the double subsidy for that month and so with those with 150 units they will also lose their single subsidy. That means they will earn less units than usual.

Q11. Where do you think there is more problems with end use efficiency, is it in the residential and commercial sectors or in the industrial sector in the country?

ANS. Initially, electric power was cheap so individuals were not conserving energy. Somebody will put on several appliances on without necessarily using them all; there were a lot of waste in the system. So when tariff prices were increased towards cost recovery then customers began realizing to do demand side management of power so they stated to use efficient appliances. For such people it cuts across but for industries, they risk a penalty for not using efficient equipment, they have maximum demand charge and then power factor surcharge. There is a limit on the power factor each company should use but if at the end of the month if they exceed that then there is a penalty for them to pay. So for the industry they are obliged to invest I efficient equipment. So some of them come for training at ECG in how to start their motors so that their maximum demand will not go above what they are suppose to use but for residential customers it is difficult to monitor.

Q12. What is the average consumption for a month in the residential sector in Ghana?

ANS. A while ago, ECG did the estimate and it was around about 240 kWh per month, but this figure is the average in the urban areas in Ghana and the rural average is about 70kWh per month.

Q13. Have there been some specific end use efficiency measures by ECG?
ANS. ECG is trying to educate end users to use power wisely, if the appliance is not in use then put it off. For example, they educate the public to iron their cloth in bulk instead of one at a time. So ECG is doing that mainly through education so that customers will use power efficiently. On the government side, through the Energy Commission, government is replacing all incandescent bulbs with CFL ones both in the cities and in the rural areas and this will definitely free some capacity for other customers either entirely new ones or incremental ones. Currently the world banking funding an educational programme to save energy and about illegal connections and power theft, and it is both for rural and urban communities.
Q14. Which groups of consumers will embarking on full cost recovery through tariff charge push for end use efficiency?
ANS. Full cost recovery tariff will ensure that if you are not using power efficiently then it will reflect in your electricity bill. Maybe this will ensure that some people may have to put off one of their refrigerators in order to reduce their energy consumption due to high tariff price. Also that will make people improve on their building fabric to improve its energy efficiency like putting wood paneling in a room before you put an air condition in the room so as to trap cold air in the room. And ECG as a utility entity will push for a full cost recovery as a means for promoting end use efficiency. Because as distribution firms there are at times we have to suppress our budget, so it is a two way affair, you make sure you provide the service without collapsing at the same time. This will also make ECG a full functional utility so that it wouldn't go bankrupt. So there should be a balance in ensuring that customers pay full cost recovery and also the utility are performing and that balance should be establish by the PURC or the Energy Commission. These regulatory bodies are responsible for that. So even in the demand and supply sense, when you increase price demand go down so that all those unwanted and unnecessary demand can be removed for production use. There are people who use power inefficiently and claim they have the money to use but they realize that, when you have power to use of you waste power, you are denying somebody of using the power. The lesions can be learned from the recent energy crises with the huge cost to the nation and when industries have to fall on their own private generators it was very expensive.
Q15. What is your opinion on regulating the market for electrical appliance to promote end use efficiency?
ANS. We have the Ghana Standard Board which ensure that gadgets that come into the country meet the standard specification though some importers are able to invade at time but they are there to ensure that the standards are adhered to and if they find to invaders they goods are destroyed and there are technical committee between VRA and ECG and within the sector. There is a law which come into force which will ban the importation of second will hand appliances especially refrigerators which are not ozone friendly. Also if consumers are paying realistic prices along with education then they will come to the realization that it cost less to buy new energy efficient appliances than old inefficiency second hand ones.
Q16. How is ECG dealing with its own internal inefficiencies due to illegal connections, theft and losses?
ANS. For power theft and non technical losses we have a number of projects running. We are doing high voltage distribution so that only about three customers will be given one transformer and also monitor four clear cut lines going to the customer meter. Now if the three customers will not be responsible enough and allow anyone to tap from the transformer, then they will pay for it. Also the transformer is manage according to the customers demand and some and a small added allowance for growth, now if they allow another customers to illegally tap from them then the whole transformer will be loaded and will be blown up, so in a way ECG is making customers responsible for the network serving them with power. This is what ECG calls high voltage distribution, they transfer power on a high voltage until it gets to the customer it is dropped to a small transformer to serve the customers. There is another ongoing project, where prepaid meter with GPS so as to locate the meters (only in the capital city, 7000 distributed so far), this is also to tackle non technical losses. Then for

households, it is prohibited to pass your service wires from an ECG distribution pole through a ceiling before coming to your metering board. There wires from the ECG distribution pole should be clearly seen entering the meter and afterward ECG put its official seal, otherwise the household will not qualify for power supply. Finally, ECG also does energy auditing for its stations and sub stations and to all customers so that they will be able to monitor how much energy is going to customers and how much energy is being used and if there is any being lost in the process. So there is large discrepancy in the energy sent and actually paid for by a customer then there is a problem and it must be investigated. There is also a loss control unit set up to monitor all illegal connection from customers.

Q17. What is the strategic importance of VACLO in the electricity end use efficiency promoting in Ghana?

ANS. VALCO is not more in operation. It is no more functional and that was in about 2-3 years ago. The mother company sold part to the government of Ghana so they are now trying to revive VALCO. If VALCO was to be in existence, Ghana would still have been in load shedding because VALCO was consuming almost half of the energy generation in Ghana.

Q18. What are the main problems and obstacles in promoting end use efficiency in Ghana?

ANS. The major challenging facing promoting end use efficiency is attitudinal. E.g., the CFL Ghana government was replacing nationwide for free, some people after replacing them will remove them and take to the market and sell them. I once recall wanted to buy CFL on the market and the one the seller gave me was inscribed with "the property of government of Ghana" and I asked him where you did get this from and he replied it is on the market being sold. And this attitudinal problem can be partly be linked to educational or illiteracy level and also partly due to economic situations (poverty).

Q19. How do you see the future trends in promoting end use efficiency in Ghana?

ANS. We should expect electricity tariff increases and customers will adjust their consumption based on price so that they will not waste power and this will force demand downwards. The demand and supply will play here. Again, one of the most efficient ways to promote end use efficiency in through realistic tariff of electricity and consumers will be somehow forced to adopt end use efficiency measures. For ECG customers the energy demand growth is about 7% per annum and it keeps increasing and all these must be supported by network expansion projects. In recent times Ghana government has given us funding to carry out our development projects but for how long will government continue to support us. So ECG thinks if they should charge economic tariff then the utilities will operate like a business entity and make sure the right things are done and able to tackle their internal problems. Right now, we are not charging economic tariff but we are also expected to deliver quality and reliable service customers. So these are the issues we have to deal with.

Q20. Do you think there should be more localized electrification projects compared to the centralized nationwide electrification project?

ANS. Now there is more effort to increase thermal generation because we cannot fully rely on the hydro generation and these are coming in from independent investors. Also planning of generating energy from the domestic waste. Also if the system becomes decentralized then it is easy to manage and monitor and also there is no need for huge financial investment compared to centralized systems. There are plans under ways to generate power with small thermal plants using natural gas from Nigeria through the West African gas pipeline project. This will be operational by next year. It has delayed because we are having some few technical difficulties with Nigeria. Also all these IPPs are combined cycle plants that means the can use light fuels as well as diesel. There could be bright future for these plants from the fact that Ghana recently discovered oil in the country.

THANK YOU.

APPENDIX B
FULL RESULTS FOR FIELD SURVEY CONDUCTED DURING THE STUDY PERIOD
Group A

QUESTION Total Number of Questions = 36	GROUGP A Total Number of respondent = 20			
1. Are you aware of how much electricity you consume at home every month/year?	Yes 20	No 0	Some times 0	Don't know 0
2. Is your electricity bill is affordable?	Yes 0	No 20	Not always	Don't know 0
3. Do you think electricity prices in Ghana are cheap compared to other neighboring countries?	Yes 0	No 20	The same 0	Don't know
4. Do you feel that final electricity users simply pay for the inefficiencies in ECG?	Yes 0	No 20	Some how 0	Can't tell 0
5. Do you think ECG has done enough to educate consumers on electricity efficiency measures?	Not enough 18	Little 2	Much 0	Very 0
6. Are you aware of link the between price and conservation measures?	Yes 0	No 20	Not always 0	Don't know 0
7. Are you always aware of electricity price increases in Ghana?	Yes 18	No 2	Not always 0	Don't know 0
8. Already conserving before electricity price increases?	Yes 0	No 20	Not always 0	Don't know 0
9. Are you willing to pay extra for improve electricity service?	Yes 0	No 20	Not always 0	Don't know 0
10. Do you think you waste electricity in your home/office in any form?	Yes 20	No 2	Sometimes 0	Don't know 0
11. Are you satisfied with the current electricity prices and the	Not very satisfied	Fairly satisfied	Very satisfied 0	Cant specify

level of services provided by ECG?	20	0		0
12. What kind of metering do you use at home?	Old type metering 0		Prepaid metering 20	
13. Do you prefer a prepaid metering or the old metering?	Prepaid 20	Old metering 0	Any of them 0	Can't tell 0
14. Have you made any changes in your electricity usage because of increasing electricity prices?	Yes, big changes 0	No, the same 20	Haven't taken notice 0	Don't know 0
15. Do you think saving electricity at home very important?	Very important 20	Important 0	Is ok 0	Doesn't matter 0
16. Do you pay flat rate for electricity or use a metering payment?	Flat rate 0	Metering charges 20	Not sure 0	Don't know 0
17. What is the main reason for saving electricity if any? Please mark.	Saving money 15		Protect environment 0	Help the country 5
18. What kind of dwelling do you use?	Compound house 0	Single family dwelling 0	Rented flat 20	Slum with no utilities 0
19. What kind of income group do you fall under by Ghanaian standards?	Below the poverty line 0	Low income, above the poverty line 0	Middle income level 20	High income level 0
20. How do you compare your monthly electricity cost to your actual monthly salary?	Very little 0	Little 0	Ok 20	Don't know 0

21. How do you pay for extra electricity charges?	Own money 20	Government subsidy 0	Both 0	Don't know 0
22. What is your educational level?	Primary 0	Secondary 0	Tertiary 20	Don't know 0
23. Did you reduce the number of electrical appliances because of increase in electricity prices?	Yes 0	No 20	Not always 0	Don't know 0
24. Do you use energy saving bulbs (CFL)	Yes 20	No 0	Not always 0	Don't know 0
25. How many electrical appliances do you use at home?	Less than 3 0	More than 3 but less than 5 20	More than 5 0	Don't know 0
26. Are you concern about the electricity concern of appliance when you buying them?	Yes 4	No 16	Not always 0	Don't know 0
27. Do you use another alternative form of energy apart from electricity?	Yes 0	No 20	0	Don't know 0
28. What are some combinations of methods adopted to reduce your electricity usage?	Switch off light when not needed 20	Buy energy efficient appliances 0	Not really concern 0	Don't know 0
29. What is the main reason if you are not able to pay your electricity bill?	Changes in financial situation 20	Rise in electricity prices 0	Changes in income levels 0	Don't know 0
30. Whom will you blame for the recent energy crisis in Ghana?	VRA 1	ECG 16	Government 3	Don't know 0
31. Do you feel motivated by the	Yes	No	Sometimes	Don't

activities of ECG to save energy?	0	20	0	know 0
32. How well do you range your knowledge about electricity efficiency measures at home?	Not much 2	Average 16	Substantial 0	Don't know 2
33. Have you ever bought electrical appliances from the second hand (used) market?	Yes 20	Never 0	At times 0	
34. How many of your current stock of electrical appliances did you buy from a second hand market?	None 0	Half of them 0	More than half 20	All of them 0
35. Which of the following electrical appliances do you use at home? (Please circle).	*Incandescent bulbs* = 0, compact florescent lights = 20, *TV* = 20 stereo/radio = 5, *stove/cooker/oven* = 0, iron, = 20 *water boilers* = 0, micro wave oven = 0, *refrigerator* = 20, computer = 20, *room air condition* = 0, others = 0			

Group B

QUESTION Total Number of Questions = 36	GROUGP B Total Number of respondent = 20			
1. Are you aware of how much electricity you consume at home every month/year?	Yes 2	No 18	Some times 0	Don't know 0
2. Is your electricity bill is affordable?	Yes 4	No 16	Not always	Don't know 0
3. Do you think electricity prices in Ghana are cheap compared to other neighbouring countries?	Yes 3	No 12	The same 0	Don't know 3
4. Do you feel that final electricity users simply pay for the inefficiencies in ECG?	Yes 0	No 20	Some how 0	Can't tell 0
5. Do you think ECG has done enough to educate consumers on electricity efficiency measures?	Not enough 18	Little 2	Much 0	Very 0

6. Are you aware of link the between price and conservation measures?	Yes 0	No 19	Not always 1	Don't know 0
7. Are you always aware of electricity price increases in Ghana?	Yes 5	No 14	Not always 1	Don't know 0
8. Already conserving before electricity price increases?	Yes 20	No 20	Not always 0	Don't know 0
9. Are you willing to pay extra for improve electricity service?	Yes 0	No 0	Not always 0	Don't know 0
10. Do you think you waste electricity in your home/office in any form?	Yes 0	No 20	Sometimes 0	Don't know 0
11. Are you satisfied with the current electricity prices and the level of services provided by ECG?	Not very satisfied 20	Fairly satisfied 0	Very satisfied 0	Cant specify 0
12. What kind of metering do you use at home?	Old type metering 20		Prepaid metering 0	
13. Do you prefer a prepaid metering or the old metering?	Prepaid 0	Old metering 20	Any of them 0	Can't tell 0
14. Have you made any changes in your electricity usage because of increasing electricity prices?	Yes, big changes 1	No, the same 19	Haven't taken notice 0	Don't know 0
15. Do you think saving electricity at home very important?	Very important 20	Important 0	Is ok 0	Doesn't matter 0

16. Do you pay flat rate for electricity or use a metering payment?	Flat rate 0	Metering charges 20	Not sure 0	Don't know 0
17. What is the main reason for saving electricity if any? Please mark.	Saving money 20		Protect environment 0	Help the country 0
18. What kind of dwelling do you use?	Compound house 20	Single family dwelling 0	Rented flat 0	Slum with no utilities 0
19. What kind of income group do you fall under by Ghanaian standards?	Below the poverty line 0	Low income, above the poverty line 20	Middle income level 0	High income level 0
20. How do you compare your monthly electricity cost to your actual monthly salary?	Very little 0	Little 0	Ok 20	Don't know 0
21. How do you pay for extra electricity charges?	Own money 20	Government subsidy 0	Both 0	Don't know 0
22. What is your educational level?	Primary 0	Secondary 20	Tertiary 0	Don't know 0
23. Did you reduce the number of electrical appliances because of increase in electricity prices?	Yes 0	No 20	Not always 0	Don't know 0
24. Do you use energy saving bulbs (CFL)	Yes 20	No 0	Not always 0	Don't know 0
25. How many electrical appliances do you use at home?	Less than 3 0	More than 3 but less than 5 20	More than 5 0	Don't know 0
26. Are you concern about the electricity concern of appliance when you buying them?	Yes	No 20	Not always 0	Don't know 0

27. Do you use another alternative form of energy apart from electricity?	Yes 0	No 20	0	Don't know 0
28. What are some combinations of methods adopted to reduce your electricity usage?	Switch off light when not needed 20	Buy energy efficient appliances 0	Not really concern 0	Don't know 0
29. What is the main reason if you are not able to pay your electricity bill?	Changes in financial situation 20	Rise in electricity prices 0	Changes in income levels 0	Don't know 0
30. Whom will you blame for the recent energy crisis in Ghana?	VRA 0	ECG 7	Government 13	Don't know 0
31. Do you feel motivated by the activities of ECG to save energy?	Yes 0	No 20	Sometimes 0	Don't know 0
32. How well do you range your knowledge about electricity efficiency measures at home?	Not much 20	Average 0	Substantial 0	Don't know 0
33. Have you ever bought electrical appliances from the second hand (used) market?	Yes 20	Never 0	At times 0	
34. How many of your current stock of electrical appliances did you buy from a second hand market?	None 0	Half of them 1	More than half 0	All of them 20
35. Which of the following electrical appliances do you use at home? (Please circle).	*Incandescent bulbs* = 3, compact florescent lights = 18, *TV* = 20, stereo/radio = 20, *stove/cooker/oven* = 20 (gas based), iron, = 18 *water boilers* = 20, micro wave oven = 0, *refrigerator* = 20, computer = 20 *room air condition* = 0, others = 0			
36. Will improved economic standing lead to acquiring new electrical appliances?	Yes 20	No 0	Not necessarily 0	Can't say

APPENDIX C
Electricity Company of Ghana and NED Sales, Customer Profile and System Losses from 2000 – 2005

YEAR	ITEM	RESIDENTIAL/NON-RESIDENTIAL	HIGHVOLTAGE >33KV	MEDIUMVOLTAGE 11 - 33KV	LOW VOLTAGE ≤ 1KV	TOTAL
2000	Customer Population	816,557	18	124	626	***817,325***
	Energy Sales (GWh)	1,807	379	435	290	**2,910**
2001	Customer Population	893,080	18	127	655	***893,880***
	Energy Sales (GWh)	1,946	439	409	285	**3,080**
2002	Customer Population	968,847	18	137	672	***969,674***
	Energy Sales (GWh)	2,016	457	432	296	**3,200**
2003	Customer Population	1,092,641	18	142	693	***1,093,494***
	Energy Sales (GWh)	2,074	480	483	305	**3,343**
2004	Customer Population	1,224,931	18	153	708	***1,225,810***
	Energy Sales (GWh)	2,190	499	541	311	**3,542**
2005	Customer Population	1,320,665	20	173	737	***1,323,978***
	Energy Sales (GWh)	2,358.40	327.84	583.74	492.04	**3,762.03**

Electricity Company of Ghana sales and customer profile from 2000 – 2005. Source: Energy Commission of Ghana

	2000	2001	2002	2003	2004	2005
Total Electricity Supplied	3,989	4,175	4,326	4,496	4,818	5,045
Total Electricity Sales Recovered	2,910	3,080	3,200	3,343	3,542	3,762
Losses (%)	*27.0*	*26.2*	*26.0*	*25.6*	*26.5*	*25.4*

Electricity Company of Ghana system looses and sales profile from 2000 – 2005. Source: Energy Commission of Ghana.

YEAR	ITEM	RESIDENTIAL	NON-RESIDENTIAL	HIGHVOLTAGE >33KV	MEDIUMVOLTAGE 11 - 33KV	LOW VOLTAGE ≤ 1KV	TOTAL
2000	Customer Population	97,147	18,099	4	2	21	**115,273**
	Energy Sales (GWh)	150	48	16	2.	15	**232**
2001	Customer Population	108,817	20,122	5	3	20	**128,967**
	Energy Sales (GWh)	165.54	54.12	14.43	2.26	13.68	**250.02**
2002	Customer Population	118,049	21,606	5	2	21	**139,683**
	Energy Sales (GWh)	172.01	57.95	21.77	2.25	11.36	**265.34**
2003	Customer Population	129,395	23,049	5	2	20	**152,471**
	Energy Sales (GWh)	181.05	59.66	26.64	2.48	13.35	**283.18**
2004	Customer Population	141,573	32,550	5	2	16	**174,146**
	Energy Sales (GWh)	200.13	70.28	27.51	3.07	21.93	**322.93**
2005	Customer Population	170,543	32,181	9	1	24	**202,758**
	Energy Sales (GWh	211.68	103.27	29.07	1.96	19.39	**365.37**

Northern Electrification Department sales and customer profile from 2000-2005. Source: Energy Commission of Ghana.

	2000	2001	2002	2003	2004	2005
Total Electricity Supplied	331	355	383	424	480	501
Total Electricity Sales Recovered	232	250	265	283	323	365
Losses (%)	*29.9*	*29.6*	*30.7*	*33.2*	*32.8*	*27.21*

Northern Electrification Department system losses and sales profile from 2000 – 2005. Source: Energy Commission of Ghana.

APPENDIX D

ANSWERED RETURNED QUESTIONNAIRE FROM PURC OF GHANA

1. BEFORE PURC WAS SETUP

- Before PURC was setup, how was electricity price determined?
  Determine by Government (both as regulator and operator)

- What were some of the regulations that determine electricity tariffs and what were the main institutions involve in the tariff setting?

2. PURC SETTUP

- What were some factors that led to the setup of the PURC?
  Public Sector Reforms

  Private Sector Participation

  Donor Conditionalities

- What are the main functions of the PURC?
  1. *To develop guidelines on rates chargeable for provision of utility services*
  2. *To examine and approve rates chargeable for provision of utility services*
  3. *To protect the interest of consumers and providers of utility services*
  4. *monitor standards of performance for provision of utility services*
  5. *promote fair competition among public utilities*
  6. *conduct studies relating to economy and efficiency of public utilities*
  7. *to make such valuation of property of public utilities as it considers necessary for the purposes of the Commission.*

- Can you please explain the main differences in the electricity tariff before and after the PURC was setup?

Before:

1. *Tariff structure was not cost reflective*
2. *Tariff levels too low to cover cost of production*
3. *Low tariffs resulted in chronic lack of investment and poor quality of service*

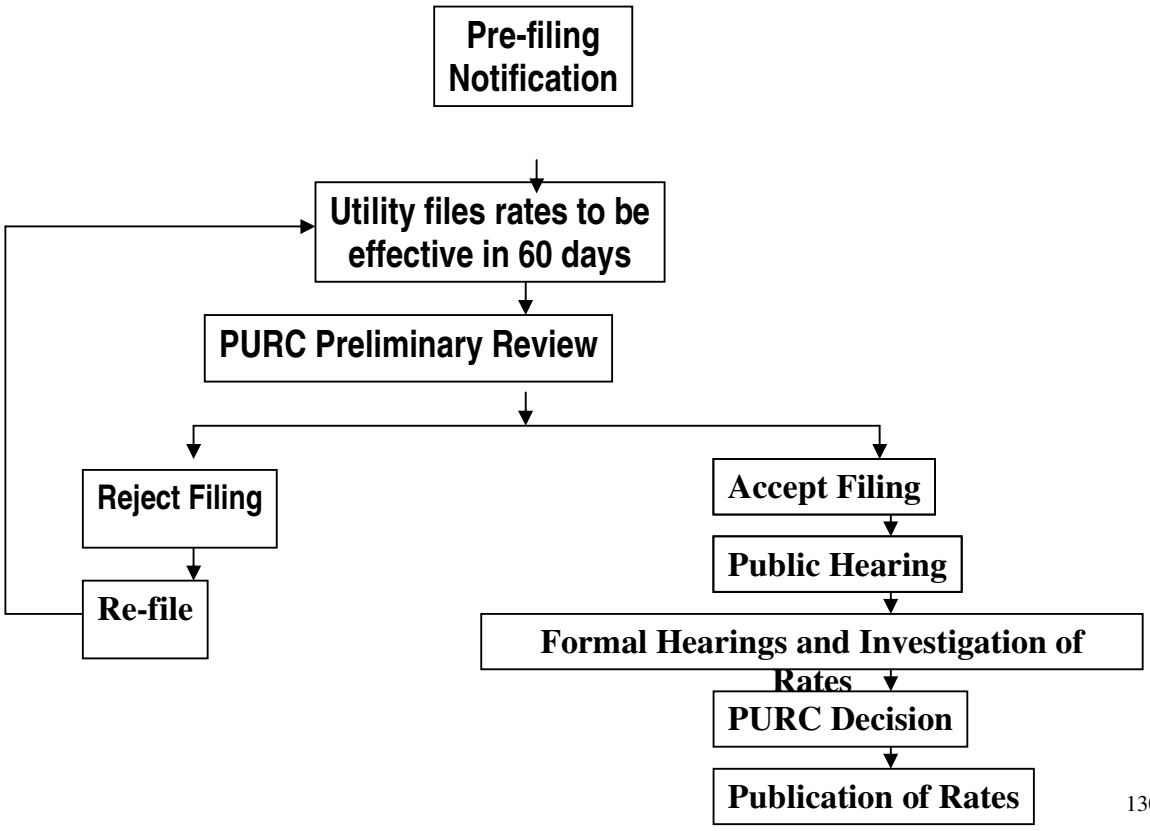
After:

- *PURC constituted as an independent body to take charge of regulatory functions including tariff setting.*

- *2000 PURC developed and issued Electricity Rate Setting Guideline*

- How does the PURC reach the final consumer price for a unit of electricity (kWh)

PURC RATE-SETTING PROCESS



130

- (components of electricity price) and what are the main institutions involve in this process?
  1. *Association of Ghana Industries*
  2. *Consumer associations*
  3. *Utilities and the government*
- How does PURC collaborate with electricity generation, distribution companies and the end users of electricity to promote und use efficiency?
  1. *Through Public Education and Awarenness*
  2. *Workshops/seminars*
  3. *Through residential and Trade associations*

3. CURRENT TARIFF LEVELS

- What is "realistic or economic tariff" and how far is the utility service in the electricity sector away from it?
    1. *Tariff that reflects all input cost*
    2. *Tariff structure inherited contained cross subsidies*
    3. *Gradual move to make structure more cost reflective*

- What is the price of a unit of electricity (kWh) consumed compared to some neighboring countries?
    1. *12cents/Kwh-average end user tariff*
- Who are the main institutions supporting or against "economic tariffs?"
    2. Coalitions
    3. Section of the public

4. FUTURE TRENDS

- What are some expected future trends in the electricity sector and electricity prices levels? *See tariff graph*
- What is the link between paying "economic tariff" and promotion of electricity end use efficiency in the residential and commercial sectors in Ghana?

  Energy conservation

  Application of power factor