CHRISTIAN SERVICE UNIVERSITY COLLEGE - KUMASI

DEPARTMENT OF BUSINESS STUDIES

BACHELOR OF BUSINESS ADMINISTRATION

THE IMPACT OF PREPAYMENT METERING ON CUSTOMER ENERGY USAGE

(A CASE STUDY OF ASHANTI EAST ECG)

A THESIS SUBMITTED TO THE DEPARTMENT OF BUSINESS STUDIES OF THE CHRISTIAN SERVICE UNIVERSITY COLLEGE, KUMASI IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF BUSINESS ADMINISTRATION.

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DECLARATION

We declare that this research work is our own, undertaken under the strict supervision of Mr. Eric Atta Appiagyei, a lecturer at the Department of Business Studies, Christian Service University College, Kumasi. It is submitted in partial fulfillment of the requirements for the award of a Bachelor of business Studies Honours (BBA Hons) in Accounting.

We wish to state that, this Research work has not been submitted before, for any Degree or examination in any University.

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ABSTRACT

This project tries to find out the impact prepayment system has had on the customer energy usage with Ashanti Region as the case study. Load management has been a major concern to (ECG) utility providers. Apart from the losses incurred and the dwindling of resources, environmental problems also crop up in terms of generation. Building of new power plants has been a great burden since it takes time and financial resources. Due to these and other problems utility providers (specifically ECG in 1994) decided to introduce prepayment meters. After the first introduction of prepayment meters (pay and smile) by ECG, different categories have been in the system. The project results indicates that the system has had a positive impact on consumers by way of helping them reduce their consumption after the introduction of prepayment system. For instance results of the project indicate that with the 28% introduction of the prepayment system in Ashanti, about 30.1% energy savings was made by ECG. Literature also reviews that energy savings were made after the shift to prepayment as reported in the Oklahoma Electric Cooperative report. The last chapter of this research is the conclusion where a number of recommendations have been made to Ghana government, Ministry of Energy, Ghana Standard Board and the utility providers.

ACKNOWLEDGEMENT

Glory be to THE MOST HIGH GOD for giving us the strength to carry out this research work. Our heartfelt thanks also goes to all those who have in one way or the other contributed to ensure that this project see the light of day.

We cannot but to mention the following names; Eric Ata Appiah Adjei (Lecturer CSUS), Mr. Edward Asare (District Technical Officer – ECG Ashanti West), Ruforson Ativuri (Regional Accounts Manager – ECG Ashanti West) and Ing. E. O. Boakye (DM Suame District – ECG Ashanti West).

Finally our appreciation goes to all those who encourage us during the period of research work. God bless you all.

DEDICATION

This project work is dedicated to our families

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CHAPTER ONE

1.0 INTRODUCTION

Throughout the world, high electric energy usage has been a matter of great concern since it relates directly to the amount of money an individual or entity pays for benefiting from the supply of energy. Some challenges that these energy utilities face are enumerated below,

- The increasing demand and supply gap
- High technical losses leading to financial losses

To solve these problems, it has been argued that the conventional credit metering system was not helping. This has necessitated the upgrading through the use of the new technologies like the prepayment metering systems that enables customers or consumers to administer or regulate their energy consumption effectively [1]. Utilities are upgrading their systems with the use of IT systems and these help increase the efficiency and utilization of their assert [1].

1.1 BACKGROUND

Energy saving is a very vital issue in every country, therefore adequate checking and restricted usage of these energy are enforced. The benefit of this energy saving is to have perfect control over the electricity bills without any doubt or argument harbored between utility management and consumers when electricity bills are distributed. Electricity, gas and water prepayment meters are now being used by the utilities to market their product, with over 20 million units installed worldwide [2][3]. Technology upgrading has increased considerably and also has offered great benefits to both utilities and consumers, such growth being the outcome of AMI technology [3][4][5][6]. Based on its implementation, some customers retracted to its use.

However, it has been positively accepted by customers who have seen its great benefit. Other developed countries account for its massive usage of 87% percentage, these being China, United Kingdom (UK) and South Africa. Apart from Turkey being 10% further, no other country goes beyond 0 .3%. China has the largest number with 7 million prepayment meters, most being electricity.UK is the largest established of prepayment meters and they account for 13%. South Africa has the largest proportion at 54% of all the electricity meters and this amount to less than 1% of the total base of all meters in the country. 50 other countries use prepayment meters but the problem being the payers [2][5].

These have been installed in tenement building and individual rented room or houses, educational institutions where human movements are mostly populated. 3.8 million prepayment meters are still in use in the UK for electricity. France has few of these meters being installed and plans are being devised to install between 500,000 and 1 million prepayment meters [2][5] [6].

Throughout the world prepayment metering has been accepted in more than 40 countries across the globe. South Africa and UK have succeeded in developing those large volumes of prepayment. On the run are other countries as follows Argentina, Bangladesh, Belgium, Brunei, Czech Republic, France, Ivory Coast, Kuwait, Israel, Lesotho, Malaysia, New Zealand, Poland and Ghana [3][2][6].

Prepayment metering was first introduced in the UK about 100 years ago. It was launched in the early 1990's in South Africa when the decision was taken to expand the level of electrification and where it has been an outstanding success. Moreover, it is until recently that China is being the largest. South Africa is now the figure head that most countries are looking to [5].The pre-payment metering system is an information Technology-based innovation which involves the purchase of electricity by consumers or customers before it use. Utilities companies across the world are now practicing this technology. While there are more demand in other countries others have less aspect of it [7][8].

As utilities invest in prepayment metering system, acceptance becomes most difficult to other consumers. Prepayment of power is a new form of payment that is enabled by today's smart metering system [9]. The prepayment metering system has improved, since it has attained a basic firm ground in other places as well as Ghana. In March 2009, Kenya Power and Lighting Company (KPLC) accepted to expand its prepayment system to 25,000 customers, in which the first phase of it was done in April 2009 [6]. KPLC owns and operates the national transmission and distribution grid and provides electricity to over 1.2 million customers throughout Kenya. KPLC connect an additional 200,000 customers each year. The awaiting objective is to convert most of the residential customers to prepayment[6].The five pacific countries in charge of the prepayment system also launched their system in August 2009.This was installed in all business, homes and offices. Along with the installation of the meters and their activation into prepayment mode, the Naura Utilities Authority is now providing 24 hour power to all its customers, thus ending the load shedding schedule that had been in place over the past several years. Residential customers will now pay their electricity entirely in cash with this initial public view about the new prepayment system had been encouraging, since customers now have 24 hour access to electricity and to pay for the improved level of service [5]. Prepayment meter was first launched in South Africa on the African continent.

Meter readers had the problem with the meter reading due to township conflict, social pressure and political conflict. These situations led Eskom to develop a basic no-frills prepayment metering system. Eskom supplied electricity to large customers in industries mining and other distributers to end users [5]. Some challenges that initiated Eskom's decision are as follows.

- Consumers withholding prepayment for a long time
- Ability to afford fixed cost in a tariff
- Access to meters in the remote areas
- Deposit management problems
- Mistrust on fixed charges in tariff structure by customers.
- Lack of postal system to allow households to check on their bills

The program lifted electrification from 33% in that year to 69% in 2003. With 7.5 million customers and 4 million prepayment meters, South Africa has the highest penetration of prepayment metering in the world. Prepayment was seen as a means of direct budgeting where the consumer was able to directly relate electricity usage with the amount of money required. In 1990 came a revolutionary change, "Electricity for All". This saw Eskom embarking on a prepayment metering system while bringing the time between purchase and consumption to as short an interval as possible. This method also enabled consumers to make conscious decisions about expenditure such as food and other household requirements against the cost of electricity.

Initially, meter manufacturers developed proprietary technologies, but now the Standard Transfer Specification (STS), developed in 1993, manages the secure transfer of credit in electricity prepayment and is the only globally accepted open standard for electricity prepayment systems, having been adopted by the International Electro-technical Commission (IEC 62055-41) [2][6]. This standard was adopted by Eskom and other supply authorities, which have subsequently replaced all proprietary meters installed with STS-compliant technologies. Prepayment meters require a robust design for a host of reasons, not least for the ability to withstand transients and other network anomalies from the high incidence of lightning in many regions of the country. This requirement has resulted in the meter designs of South Africa being superior to those sourced from other countries [6].

The advantages of prepayment metering have led the regulators to support its implementation in India [1]. In one of the other utilities which had adopted prepayment to ensure 100% cash collection in advance, reduce system losses, provide better customer services, and ensure load management to optimize its availability and distribution of supply. The results that were achieved are noteworthy. After installing more than 10,000 prepayment meters, there was a revenue improvement of 30% within the first month due to accurate billing. Also due to energy consciousness, the energy demand on the average had reduced from 3MW to 2.5MW; a reduction of 17% [2]. Many state regulators have introduced reduced electricity charges for consumers with prepayment metering. Apart from this, the Ministry of Power in New Delhi has issued a notification to implement prepayment metering for all government offices and residences [1][3].

Since the meters show energy consumption in money terms, the consumers can see the cost of energy in real time; this provides a strong push to reduce their consumption as that saves money. On the whole, the fact that prepayment meters help make customers energy conscious and persuade them to budget their expenditure on electricity has been empirically proven. The importance and the role of prepayment metering for helping us to conserve energy is further corroborated. The success of the pilot trials has provided the consumers as well as the utility the required confidence to willingly adopt the prepayment systems [10].

Most electricity in the United States is generated from fossil fuel-based power plants. The burning of coal and natural gas to generate electricity produces greenhouse gas emissions and also generates significant air pollutants, such as particulate matter and sulfur dioxide. Electricity used at Clark University is purchased through National Grid, or generated by the 1,600 kW generators in the cogeneration plant. By reducing our consumption of electricity we both reduce greenhouse gas emissions and pollution, and save money [10].

Electricity on campus is mostly used for lighting, heating, ventilation and air conditioning (HVAC), computing, refrigeration and general-purpose use. Clark does not have extensive metering built into its electrical infrastructure, so detailed information at this time, is impossible to generate [10].

Electricity consumption at Clark has gone up and down over the past three years. In 2004 the main campus consumed a total of 11.4 million kilowatt hours of electricity. In 2005, electricity consumption increased to 12.0 million kilowatt hours (an increase of 5.0 percent), before falling back to 11.7 million kilowatt hours in 2006 (a decrease of 2.5 percent). Fig 1.0 below depicts the above statistics of electricity consumption on Clark campus [10].

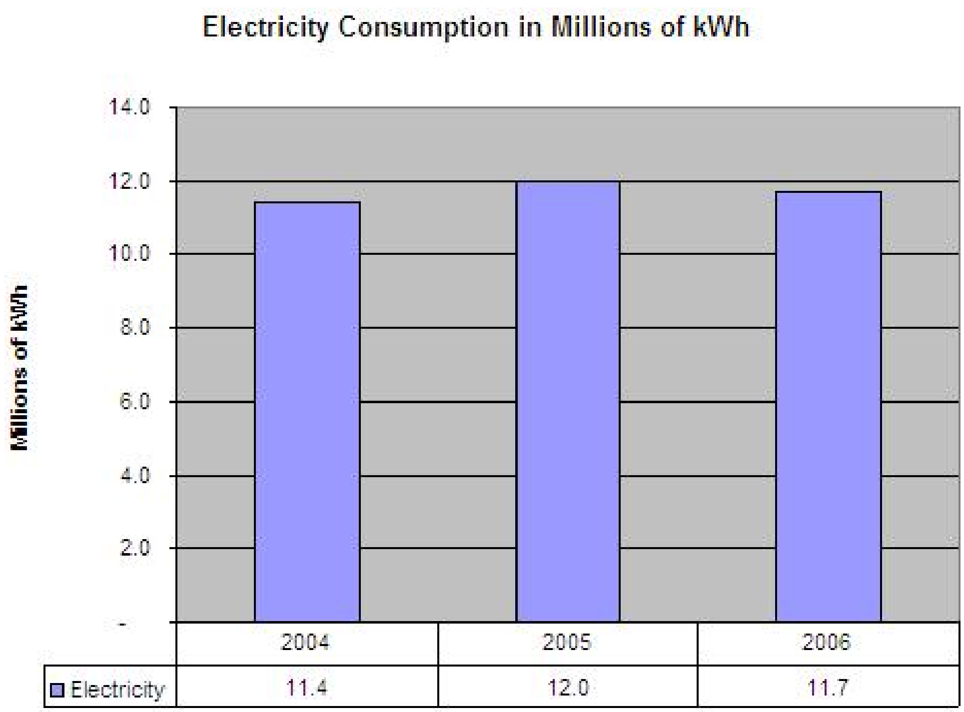


Figure 1.0. Electricity consumption (kWh) verses period (years) in Clark University

In 2004, Clark consumed 9.27 kilowatt hours of electricity per square foot of campus buildings. In 2005, this electricity consumption increased slightly to 9.29 kilowatt hours per square foot (an increase of 0.3 percent) and then was reduced to 9.06 kilowatt hours per square foot in 2006 (a decrease of 2.5 percent).

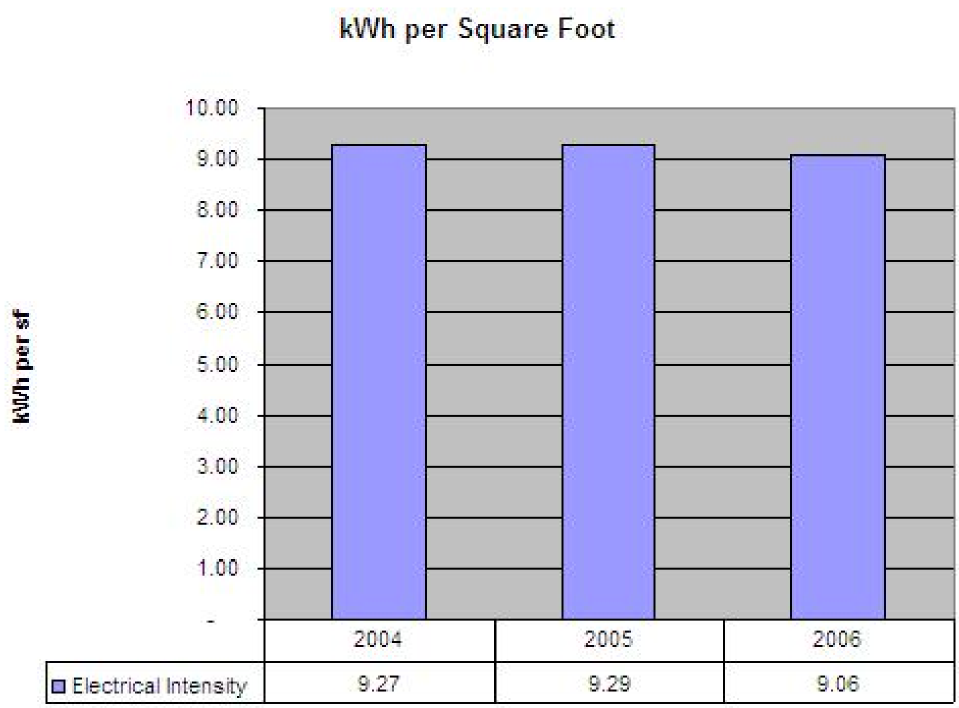


Figure 2.0. Electricity consumption (kWh per sq. ft.) verses period (years)

It is clear that Clark has done better in reducing our consumption of thermal energy than in lowering electrical consumption. This is in large part due to the rapid increase in the amount of computing on campus, and Clark's limited success to date in reducing the usage of energy in providing this computing capacity on a "24/7" basis. Many electricity savings initiatives are already impacting Clark's results. Clark has introduced the newest generation of energy efficient lighting in Wright Hall, the Kneller Center, the Higgins Dining Room, IDCE House, Math/Physics, the Lasry Center for Bioscience and Blackstone Hall [10].

Currently, a campus-wide lighting inventory is being compiled to take further advantage of the National Grid lighting efficiency rebate program in the hope that all of the lighting fed from the main meter will be energy efficient. Replacement of electric heat in a section of the Geography building with hot water fed from the cogeneration plant will lower electricity consumption. Replacing the fan motors for the Goddard Library HVAC system with variable frequency drives during the upcoming renovations will also contribute to the cogeneration plant's overall efficiency by allowing the generator to follow campus load rather than maintain a 250 kW reserve so the fans may be cycled on and off. An energy awareness group comprised of concerned students and staff is working with ITS to decrease overall energy consumption starting with shutting down office desktops and peripheral equipment.

With a customer base of approximately 1.4 million, it has been estimated that 45-47 percent of Ghanaians, including 15-17 percent of the rural population, have access to grid electricity with a per capita electricity consumption of 358 kWh. All the regional capitals have been connected to the grid. Electricity usage in the rural areas is estimated to be higher in the coastal (27 percent) and forest (19 percent) ecological zones, than in the savannah (4.3percent) areas of the country. In 2004, Ghanaians consumed 5,158 gigawatthour (GWh) of electricity. It is estimated that about half of this amount is consumed by domestic (or residential) consumers for household uses such as lighting, ironing, refrigeration, air conditioning, television, radio and the like. Commercial and industrial users account for the rest. The majority of the customers are in service territories of the Electricity Company of Ghana (ECG) and the Northern Electrification Department (NED), and they are regulated (Table 1.1) [11].

However, there are also deregulated consumers such as mines, and aluminum companies, which account for one third of total consumption. One industrial entity, VALCO, can account for most of this amount when it is operating normally. Residential consumers comprise middle and high-income urban consumers. This consumer-class typically uses a number of high energy consuming household appliances and items such as air conditioners, fridges, water, a substantial amount of lighting equipment and bulbs for the houses [11].

Table 1.0 ECG and NED Customer population and energy consumption,

Customer	Number of Customers	Energy Consumption (GWh)
ECG	1,200,000*	4,818
NED	188,344	340
TOTAL	**1,388,344**	**5,158**

*Includes active customers, non-active customers and bulk customers

The major characteristic residential arrangement is the “compound house” multi-house phenomenon – essentially a number of households living in a compound and sharing basic amenities including one electricity metering system. Apart from residential consumers who are considered to be “small “users, other consumers whose consumption is not considered large by virtue of their activities are the nonresidential consumers as well as small industrial concerns which are known as special load tariff customers (SLT’s). Non-residential consumers comprise offices, banks and other small businesses. Since the 1980’s, the government has pursued a policy of extending electricity to the rural majority of the rest of the residential consumers use electric power for lighting [11].

1.2 JUSTIFICATION

Since the introduction of electricity in Ghana, most of the electricity users notably residential, commercial, industrial, educational institutions and other government agencies have been using the credit meters. The difficulty of consumption monitoring associated with the credit meters gave rise to high energy consumption. The Government of Ghana recently directed that the utility providers (ECG and VRA-NED) should as a matter of urgency, install prepayment meters in all educational and Government agencies in the country. The essence of the project therefore is to access the impact prepayment metering has had on customer energy usage in Ghana, using Ashanti East as a case study.

1.3 AIMS AND OBJECTIVES

This project is aimed at assessing the impact of prepayment metering on customer energy usage in Ghana with Ashanti Region as a case study. The objectives are as follows:

- To review the literature on prepayment metering systems
- To obtain from ECG the relative percentages of prepayment and conventional credit meters customers.
- To get historical records of energy consumption before and after introduction of prepayment meters.
- To document the consumption pattern and statistical analysis to show the extent to which the switch to prepayment metering has reduced energy usage; any energy cost savings.

CHAPTER TWO

LITERATURE REVIEW

2.0 PREPAYMENT METERING SYSTEM

Prepayment metering is the trade measurement of electricity which is required to be purchased by a consumer in advance of the consumption of electricity. Generally, in a prepayment application, a consumer must prepay for electricity in order to activate their load through the meter. The types of prepayment applications for electricity may vary and can range from a simple advance monetary payment for electricity to the pre-purchase of a fixed quantity of electricity. In principle, under a prepayment application, the consumer may not receive a subsequent bill as payment is made in advance for electricity [2][6]. The terms and conditions for prepayment are established by the electricity and the utility service (also referred to in the industry as suppliers or energy providers), and are subject to regulation by the Provinces.

In their earliest form, prepayment meters consisted of coin operated mechanical meters.

From the late 1980's forward, electronic meter technology combined with card encoding and various telemetering communication techniques have been used in prepayment meter design. In recent years, there has been a growing interest amongst government departments and industry stakeholders to identify new methods for managing and conserving energy to meet rising demand at the residential and commercial/industrial trade levels. In the electricity industry, the use of prepayment applications combined with time-of-use is being closely reviewed as a viable means for reducing overall demand in the electricity marketplace [12].

In general, it is considered that the electricity prepayment meter measures energy in the same manner as a conventional meter. The main difference with a prepayment meter lies in the intended manner in which the meter is to be operated and used for the sale of electricity.

In the case of a conventional electricity meter, once a customer's load is energized, energy consumption is measured integrally on a continuous basis and a measurement reading is taken or established by the utility service on a periodic basis for the purpose of establishing a charge for electricity. Payment for electricity is made by the purchaser following the declaration or estimation of consumption of electricity for a certain period of time [12].

In the case of a prepayment electricity meter, the meter also measures electricity consumption integrally but the measurement is actually started and stopped in conjunction with the activation and deactivation of the load circuit by the prepayment control system. To activate the load circuit, the consumer must prepay for electricity usage or purchase a quantity of electricity (note: the utilities' fixed charges may be included in this purchase). The payment information may be loaded on the meter through a specific peripheral control device (e.g., magnetic card reader or telemetering system). Once activated, the load circuit will run and remain activated until the monetary or equivalent energy information loaded into the prepayment control system has run out, subject to any other conditions established by the utility services [13].

2.1 CLASSIFICATION OF PREPAYMENT METERS

The types of prepayment meters with respect to this project are under listed below:

- Smart card electronic prepayment meter
- Token prepayment meter
- Remote control prepayment meter
- Key prepayment meter

2.1.1 Smart card electronic prepayment meter

(a) (b)

Figure 3.0. A smart Card Prepayment Metering System (a) on Electronic Energy Meter (b)

Smart Card Prepayment Metering System is a new billing methodology that is combining a superior electronic customer account management system, state-of-the-art metering equipment and smart card technology and provides Power Utility, a substantial saving both in manpower and money while providing new payment option for the customers. It reduces operational cost with paperless revenue [14]. The system eliminates the need of sending a meter reader to collect data at the customer premises. Instead as a customer inserts his charged Smart Card into the meter and the information such as total kWh consumption, previous 12-month kWh consumption, available credit among others, is then transferred by the meter to the card. The downloaded data will then be transferred to the utility database once the customer recharges their card [14].

The various available softwares that can be embedded into the meter, the Smart Card and the backend system together make the system very flexible and can cater for any utility requirement. An electronic prepaid kWh meter will act as a “bank”, as long as some credit is available inside the meter, electricity will be made available to the customer. The level of credit inside the meter will be deducted according to the tariff as programmed for the respective customer [15].

Smart meters go a step further than simple AMR (automatic meter reading). They offer additional functionality including a real-time or near real-time reads, power outage notification, and power quality monitoring. They allow price setting agencies to introduce different prices for consumption based on the time of day and the season. These price differences can be used to reduce peaks in demand (load shifting or peak lopping), reducing the need for additional power plants and in particular the higher polluting and costly to operate natural gas powered peaker plants. The feedback they provide to consumers has also been shown to cut overall energy consumption [16].

2.1.2 Token prepayment meter

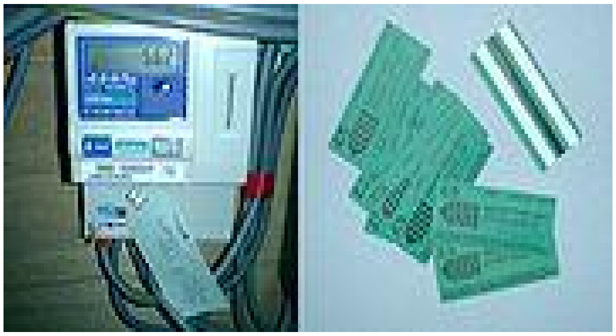


Figure 4.0. A magnetic/token prepayment system

This system of metering which made use of Tokens was introduced in the late 1980s and was adopted by approximately half of the UK utilities. Many suppliers expressed a certain amount of dissatisfaction with token meters which are the oldest technology in use. They are the most basic type of prepayment meters and have a number of limitations including a greater susceptibility to fraud and misdirected payments than the other types of meters, high maintenance cost deriving from the need for site visits, inflexibility in the recovery of debt, and general account balancing issues [14].

Tokens for prepayment can be categorized as being "One-Way" or "Two-Way". The one-way tokens transfer credit and control information from the sale point to the meter and the tokens are usually discarded after use. The major drawback with one-way is that the supplier cannot know how much electricity has been disbursed through the prepayment meter. Personnel therefore have to visit the customer's premises to verify consumption physically. The two-way tokens require the customer to return to the point of sale for the next purchase. This allows the supplier personnel to read the data stored by the meter from the returned token [14].

Two types of token technology are currently in use: Disposable paper card with magnetic stripe and Numeric tokens which are strips of paper with a unique, encoded 16 or 20 digit numbers to be entered by the customer via a keypad on the face of the meter. This makes the token essentially a slip of paper, very cheap to produce [14].

2.1.3 Remote-controlled prepayment meter

Figure 5.0. Remote-controlled prepayment meters

Remote Control (RC) Prepayment System is composed of prepayment watt-hour meter, RC controller, energy dispenser device, and management software. RC controller is a carrier for data exchange between meter and management system. The system could make it easy to control and manage electricity consumption [14].

The prepayment watt-hour meter has constantly been improved. It is very popular in China and welcomed by the customers due to its advanced design, sound quality, flexible setup, competitive price, and good technical support [14].

2.1.3.1 The operation of remote controlled prepayment meter

The current signal and voltage signal will be sent to a special integrated circuit after sampling and dividing, and then treated by special CPU chips to obtain the pulse signal of frequency positive rated to load consumption power. The pulse signal to be sent to LED and the value of power through the meter will be indicated by the speed-ratio of pulse number/kWh. Even when the connection is not correct which causes the adverse power, the meter can also recorded the data correctly [14].

2.1.3.2 Some characteristics of remote-controlled prepayment meter

a) Controlled by the Micro-PC with Advanced SCM, measured digitally and with smart anti-tampering function (no influence in measurement and keep record if connection is in reserved between input and output wire)

b) Both Meter and Power-selling Management System could read the RC card that could re-record the remains, accumulative energy and working status of meter.

c) It keeps data security automatically once power failed and recovery completely as power back.

d) Meter could work on the base of that only any one of three phases has the electricity

e) Low power consumption, mini volume; tamper proof function and no confined condition for installation

f) It adopts the load switch with high overload capability and magnetic retainable relay switched by high reliability impulse

2.1.4 Key Prepayment Meters

Key prepayment systems, where the customers charge their key at a payment outlet, were introduced in the early 1990s and are used by 1.5 million customers in the UK. The interest in prepayment metering technologies has grown throughout the world as electricity supply authorities search for more cost effective solution to customer service demands while ensuring consistent revenue streams. In an attempt to address how complex tariffs, customer service and cost effectiveness new system were put in place.

This invention concerns a prepayment metering system using a key on which information may be stored and from which information may be erased. This comprises a terminal having means for receiving the key, means for reading a first number recorded on the key, encryption means utilizing the first number to obtain a second number, and recording means for recording the second number on the key in place of the first number, and further comprising a meter having means for receiving the key, means for reading the said second number from the key, a store in which is stored the first number, read from the key during its previous insertion, means for carrying out a comparison step involving a complementary decryption process or the same encryption process and utilizing the second number from the key and the first number stored in the meter, and means for registering a credit if the comparison is successful, the meter then replacing the first number in its store by the second number read from the key in preparation for the next key insertion [2][17][6].

In one embodiment the first number read from the key at the terminal station is itself encrypted using a key stored in the terminal station to provide the second number to be recorded on the key in place of the first number. At the meter, the second number read from the key is subjected to a decryption process utilizing a key stored in the meter, which corresponds to the stored in the terminal station, and is then compared with the said first number stored in the meter [2][6].

2.2 SOME BENEFIT OF PREPAYMENT METER

Prepayment for electricity is a way of life in many countries and for good reason [18].

2.2.1 For customers, Smart Grid prepayment means:

- No deposits.
- No monthly bills.
- Smaller payment amounts over time. Experience shows that customers frequently make weekly payments of $10 or $20.
- Easy consumption monitoring.
- Greater awareness and control of costs.
- No late payment or reconnection charges.
- Voluntary participation.
- No extra cost (because there's little or no special equipment).
- Dignity. Anecdotes indicate that this is one of the most important benefits of prepayment.

Families struggling with bills can keep their relationship with utility companies entirely private. There are no utility crews pounding on doors and yelling about meter shut-offs in full sound and view of the neighbors. Disconnection is entirely under the customer's control [18].

2.2.2 For the utility, Smart Grid prepayment means:

- Improved cash flow.
- Reduced credit & collections costs. There are no confrontations on the phone, no turning
- Over accounts to collection agencies. And prepayment easily accommodates gradual payments of past-due bills without manual monitoring.
- Lowered write-off expense.
- Promotion of energy conservation.
- Reduced high-bill complaints.
- Increased customer satisfaction.
- No costs for extra equipment or infrastructure.
- Use of existing payment methods.
- No paper bills.
- Reduced disconnects/reconnects by field crews, with associated improvements in employee safety and productivity.

2.3 PREPAYMENT METERING IMPLEMENTATION IN GHANA

Over the years, the VRA-NED and ECG have used the conventional credit metering and billing system in their revenue collection efforts. Measures such as termination of service of defaulters, use of bonded cashiers, private debt collection companies, threat of prosecution and raffles did not result in a significant reduction in the debtors' position of the utility service providers. Rather, the debtors' position of these companies worsened. Prepayment metering was seen as a better option for improving the cash flow position and reducing the level of debts owed to these companies by customers. Between 1994 and 1995 ECG ran the prepayment programme on a pilot basis in Accra, Tema and Kumasi for residential and non-residential customers with small loads. Areas where the meters were installed were Adenta SSNIT flats and surrounding areas, Sakumono Estates, some communities in Tema, Asuoyeboah SSNIT flats, Kwadaso, Patase and Danyame areas of Kumasi [19]. Based on the implementation in Ghana, there were some improvements these being;

- Improving revenue collection
- Creating awareness on the need for customers to conserve energy and reduce wastage
- Reducing costs associated with meter reading, billing errors, bill production and delivery of bill

2.4 METHODS OF BILLING IN PREPAYMENT SYSTEM

The billing processes are based on the following:

- Electromechanical Technology
- Communication Technology
- Automatic Reading

2.4.1 Electromechanical Technology

The electromechanical induction meter operates by counting the revolutions of an aluminum disc which is made to rotate at a speed proportional to the power. The number of revolutions is thus proportional to the energy usage. It consumes a small amount of power, typically around 2 watts. The metallic disc is acted upon by two coils. One coil is connected in such a way that it produces a magnetic flux in proportion to the voltage and the other produces a magnetic flux in proportion to the current. The field of the voltage coil is delayed by 90 degrees using a lag coil. This produces eddy current in the disc and the effect is such that a force is exerted on the disc in proportion to the product of the instantaneous current and voltage. A permanent magnet exerts an opposing force proportional to the speed of rotation of the disc. The equilibrium between these two opposing forces results in the disc rotating at a speed proportional to the power being used. The disc drives a register mechanism which integrates the speed of the disc over time by counting revolutions, much like the odometer in a car, in order to render a measurement of the total energy used over a period of time [20].

2.4.2 Communication Technology

Remote meter reading is a practical example of telemetry. It saves the cost of a human meter reader and the resulting mistakes, but it also allows more measurements, and remote provisioning. Many smart meters now include a switch to interrupt or restore service. Historically, rotating meters could report their power information remotely, using a pair of contact closures attached to a KYZ line. In a KYZ interface, the Y and Z wires are switch contacts, shorted to K for half of a rotor's circumference. To measure the rotor direction, the Z signal is offset by 90 degrees from the Y. When the rotor rotates in the opposite direction, showing export of power, the sequence reverses. The time between pulses measures the demand. The number of pulses is total power usage [20].

2.4.3 Automatic Reading

AMR (Automatic Meter Reading) and RMR (Remote Meter Reading) describe various systems that allow meters to be checked without the need to send a meter reader out. This can be effectively achieved using off-site metering, that is an electronic meter is placed at the junction point where all the connections originate, inaccessible to the end-user, and it relays the readings via the AMR technology to the utility [20].

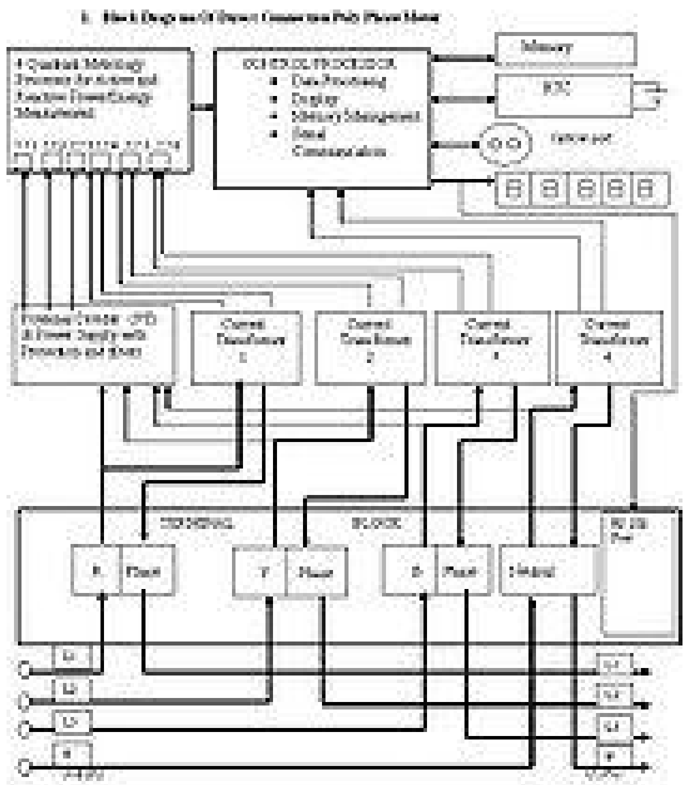


Figure 6.0. The basic block diagram of an electronic energy

As in the block diagram (figure 6.0), the meter has a power supply, a metering engine, A processing and communication engine (i.e. a microcontroller), and other add-on modules such as RTC, LCD display, communication ports/modules and so on. The metering engine is given the voltage and current inputs and has a voltage reference, samplers and quantizes followed by an ADC section to yield the digitized equivalents of all the inputs. These inputs are then processed using a Digital Signal Processor to calculate the various metering parameters such as powers, energies and so on. The largest source of long-term errors in the meter is drift in the pre-amp, followed by the precision of the voltage reference. Both of these vary with temperature as well, and vary wildly because most meters are outdoors. Characterizing and compensating for these is a major part of meter design. The processing and communication section has the responsibility of calculating the various derived quantities from the digital values generated by the metering engine. This also has the responsibility of communication using various protocols and interface with other add on modules connected as slaves to it.

RTC and other add-on modules are attached as slaves to the processing and communication section for various input/output functions. On a modern meter most if not all of this will be implemented inside the microprocessor, such as the Real Time Clock (RTC), LCD controller, temperature sensor, memory and analog to digital converters [20]. When energy suppliers increase or cut their prices, customers with Smart card or Key prepayment meters automatically have their prices changed. For households using Token prepayment meters, price changes are manually effected at the vending points [21].

2.5 EFFECTS OF PREPAYMENT METERING ON CUSTOMER ENERGY USAGE

Prepayment has gained increased attention in the last several years. The primary reason is that customers switching from credit billing to prepayment almost always reduce their electricity consumption.

- Salt River Project reports a 12.8 percent reduction in energy use when customers switch from credit to prepay [22].

- Northern Ireland Electricity says that prepay customers use 4.9 percent less electricity than the average customer [23].
- Oklahoma Electric Cooperative reports that customers lowered consumption 13 percent after switching to prepayment [24].

Granted, customers electing prepayment are likely to be those most motivated to reduce utility bills. However, in the vast majority of cases, these customers were equally motivated under a Credit billing system. What was missing was the immediate feedback of knowing,

1) exactly how much power they were using in near real time, and

2) how closely their consumption Matched their planned budget.

In recent months, Measurement Canada [25] has received requests for information from electricity meter approval applicants and contractors regarding the Agency's policies and requirements for prepayment meters. As a result of initiatives being introduced and promoted in certain provincial deregulated electricity markets, there is a growing interest in the use of prepayment applications as a method for managing and conserving energy to meet the rising demand for electricity. In the electricity industry, the use of prepayment applications combined with time-of-use multi-rate billing functions is being closely reviewed as a viable means for reducing overall demand [25].

This evolution in the use of prepayment metering has required Measurement Canada to review the applicable requirements of the Act, Regulations, and meter approval and verification specifications. As a result of this review, Measurement Canada has determined that a policy is needed to clarify the federal requirements and the Agency's position with regard to approval, verification, installation and use of prepayment meters [25].

To meet the immediate need to service approval applications, Measurement Canada has developed draft approval-of-type specifications, contained in this document, which will be authorized for use under bulletin GEN-06[25]. Pursuant to the policies of bulletin GEN-06, meters which successfully meet the criteria of the authorized draft specifications will receive a conditional approval. A decision to grant full approval will be performed once formal national specifications have been adopted by Measurement Canada and all approval conditions have been met. Measurement Canada will undertake the development of formal national specification in consultation with electricity and gas industry stakeholders [25].

Prepayment is especially popular with customers who: [oracle]

- Share room with others and want to ensure that no one moves out without paying a fair share of the utility bill.
- Need to win the cooperation of children in reducing energy budgets. Children may be far more responsive to an in-home display showing little television time remaining than they are to parental admonitions to turn off unneeded lights.
- Need to ensure that they do not inadvertently exceed tightly budgeted amounts for utilities.
- Want to reduce energy use for either financial [10] or environmental [26] reasons.

Prepayment provides a discipline that many customers find helpful [10]. In a July 2008, Chartwell Webinar on prepayment, Jonna Buck at Oklahoma Electric Cooperative cited the following letter to illustrate this point:

"I appreciate customer service recommending prepaid using when we were in a bind. It has helped us to understand how much electricity we really use and to help us maintain a lower bill then being surprised when a monthly bill comes.” [26]

It is important to note that low-income customers often have the most incentive to use the system to conserve. In general, it appears that the higher the prepayment penetration, the lower the conservation rate.

2.6 ENERGY CONSERVATION

2.6.1 Definition

Energy conservation refers to efforts made to reduce energy usage. Energy conservation can be achieved through increased efficient energy use, in conjunction with decreased energy consumption and/or reduced consumption from conventional energy sources [26].

2.6.2 Importance of conservation

Because of the limited amount of non-renewable energy sources on Earth, it is important to conserve our current supply or to use renewable sources so that our natural resources will be available for future generations [18].

Energy conservation is also important because consumption of non-renewable sources impacts the environment. Specifically, our use of fossil fuels contributes to air and water pollution. For example, carbon dioxide is produced when oil, coal, and gas combust in power stations, heating systems, and car engines. Carbon dioxide in the atmosphere acts as a transparent blanket that contributes to the global warming of the earth, or "greenhouse effect." It is possible that this warming trend could significantly alter our weather. Possible impacts include a threat to human health, environmental impacts such as rising sea levels that can damage coastal areas, and major changes in vegetation growth patterns that could cause some plant and animal species to become extinct [18].

Sulfur dioxide is also emitted into the air when coal is burned. The sulfur dioxide reacts with water and oxygen in the clouds to form precipitation known as "acid rain." Acid rain can kill fish and trees and damage limestone buildings and statues. You can help solve these global problems. In the U.S.A., the average family's energy use generates over 11,200 pounds of air pollutants each year. Therefore, every unit (or kilowatt) of electricity conserved reduces the environmental impact of energy use.

2.6.3 Energy sources

Electricity is generated from both renewable and nonrenewable energy sources. These sources are defined below.

2.6.3.1 Renewable energy sources

These sources are constantly renewed or restored and include wind (wind power), water (hydropower), sun (solar), vegetation (biomass), and internal heat of the earth (geothermal). About 9.0 percent of electricity in the U.S. is generated from renewable sources. [26]

2.2.3.2 Non-renewable energy sources

These are natural resources that cannot be replenished (fossil fuels such as oil, gas, and coal). About 71.5percent of electricity in the U.S.A is generated from non-renewable sources.

In addition to renewable and non-renewable energy sources, about 19.5 percent of electric power in the U.S.A is generated by nuclear power plants. However, operating such plants poses significant nuclear waste disposal problems; consequently, there are no current plans to build more [26]. Most electricity in the U.S.A is generated by burning nonrenewable fossil fuels and there is a limited amount of these energy sources [26].

2.7 CONSERVATION EFFECT

Energy conservation can result in increased financial capita and environmental quality. Individuals and organizations that are direct consumers of energy choose to conserve energy to reduce energy costs and promote economic security. Industrial and commercial users can increase energy use efficiency to maximize profit [26].

2.7.1 Financial capital

Financial capital can refer to money used by entrepreneurs and businesses to buy what they need to make their products or provide their services or to that sector of the economy based on its operation. Conserving energy, funds used in payment of bills could be channel to other meaningful investment [26].

2.7.2 Environment quality

The environment quality, encompasses all living and non-living things occurring naturally on Earth or some region thereof. It is an environment that encompasses the interaction of all living species [26]. The concept of the environment quality can be distinguished by components:

Complete ecological units that function as natural systems without massive human intervention including all vegetation, microorganisms, soil, rocks, atmosphere and natural phenomena that occur within their boundaries.

Universal natural resources and physical phenomena that lack clear-cut boundaries, such as air, water, and climate, as well as energy, radiation, electric charge, and magnetism, not originating from human activity. The environment quality is contrasted with the built environment, which comprises the areas and components that are strongly influenced by humans. A geographical area is regarded as a environment quality (with an indefinite article), if the human impact on it is kept under a certain limited level. Very large development projects - megaprojects - pose special instructions and risks to the natural environments. Major dams and power plants are cases in point. The challenge to the environment from such projects is growing because more and bigger megaprojects are being built, in developed and developing nations alike [27].

Since the implementation of Westlothian Council Energy and Water Strategy in 2005-06, the provision of energy training, awareness raising and implemented measures have saved over £900,000 in energy costs and over 5,000 tons of CO_2 of emissions. The council currently spends over £6 million each year on energy and £1 million on water charges. Our total annual energy consumption is over 130 million kWh [28].

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

This section deals with the ways adopted to conduct the research. It indicates the target population and samples as well as the instrument used in gathering data. It also includes how the data was collected and how it was analyzed.

3.1 RESEARCH DESIGN

The research design used for the study was of an assessment, which relied on the database of ECG and interviews as well as secondary sources like websites , textbooks, journals and works of scholars to collect data for analysis. The choice of this design was made against the background that the study seeks to find out the effect of prepayment meters on customer energy usage. The main concern here is about the effective use of electricity. To be able to find out how the introduction of prepayment meters has influenced the electricity consumer in Ghana. The research design therefore targeted the utility provider (ECG) and its customers.

3.2 POPULATION AND SAMPLE

The population involved in this project is all ECG customers in Ghana. The sample consists of ECG customers in Ashanti East and randomly selected customers in Suame and Asokwa in Ashanti East and West respectively. The choice of this sample stems from the fact that access to data and data gathering will be easy.

3.3 INSTRUMENTS

The main instruments used in the collection of data were introductory letters from the Department of Electrical/Electronic Engineering of the Kwame Nkrumah University of Science and Technology (KNUST) to ECG, use of non-structured interviews, internet and textbooks.

3.4 DATA COLLECTION METHOD

Data was obtained from the internet (thus, websites), journals, textbooks, prepared document of professional's, ministries and documents of other organizations or agencies. The researchers obtained introductory letters from the KNUST Electrical Department office introducing the team as students embarking on this project. These letters were sent to ECG Ashanti East, Ashanti West and Takoradi. However data was obtained from only Ashanti East and West Region. The researchers personally interviewed sampled customers to obtain their prepayment consumption history after their credit meter consumption history was generated from ECG database.

3.5 DATA ANALYSIS

Descriptive statistics, tables and graphs of Microsoft Excel and Word were used in the analysis of the raw data obtained and in the presentation of this thesis.

CHAPTER FOUR

DATA DOCUMENTATION AND STATISTICAL ANALYSIS

4.0 INTRODUCTION

This chapter covers the documentation of data obtained from the Electricity Company of Ghana (ECG), Ashanti East and West Regions and the statistical analysis of the raw data. From the raw data, the customer population, their consumptions and sales of the various districts of the two regions of ECG have being displayed Appendix 1-22. The political administrative region of Ashanti is divided into two, Ashanti East and Ashanti West for ECG administrative purposes. Ashanti East Region comprises the following districts, Asokwa, Ayigya, Manhyia, Kwabre, Effiduasi, Mampong and Konongo. Ashanti West on the other hand include Dunkwa, Obuasi, Offinso, Bekwai, Abuakwa, Danyame, Suame, New-Edubiase Districts.

Each of the districts is again divided into different billing groups for easy administrative work. There is also a group of customers in each ECG administrative region who does not belong to any district and they are referred to as special load tariff (SLT). For the purpose of our project this group of customers is classified as a district. Also in the documentation are historical records of fifty customers in Suame and eighty customers in Asokwa who have shifted from credit meter to prepaid meter usage as sample for our case study shown in Appendix 23and 24.

4.1.1 Historical Records of ECG Ashanti East and West Regions

In the Appendixes 1-22 are the documented and statistical data obtained from ECG raw data to be used for the project analysis. From the Appendixes, the following information can be obtained:

- The number of customers in each billing group and the total customers of each district, their consumption, the sales, the average unit per customer for both credit and prepaid customers and the savings made are indicated.
- The savings made per customer is the difference between the average units per customer for credit and prepaid. The total customer population for Ashanti Region is shown in Table 4.1

Table 4.1 The customer population in Ashanti

	Credit customers	Prepaid customers	Total
Ashanti East Region	110,277	49,763	160,040
Ashanti West Region	154,491	53,595	208,086
Total	**264,768**	**103,358**	**368,126**

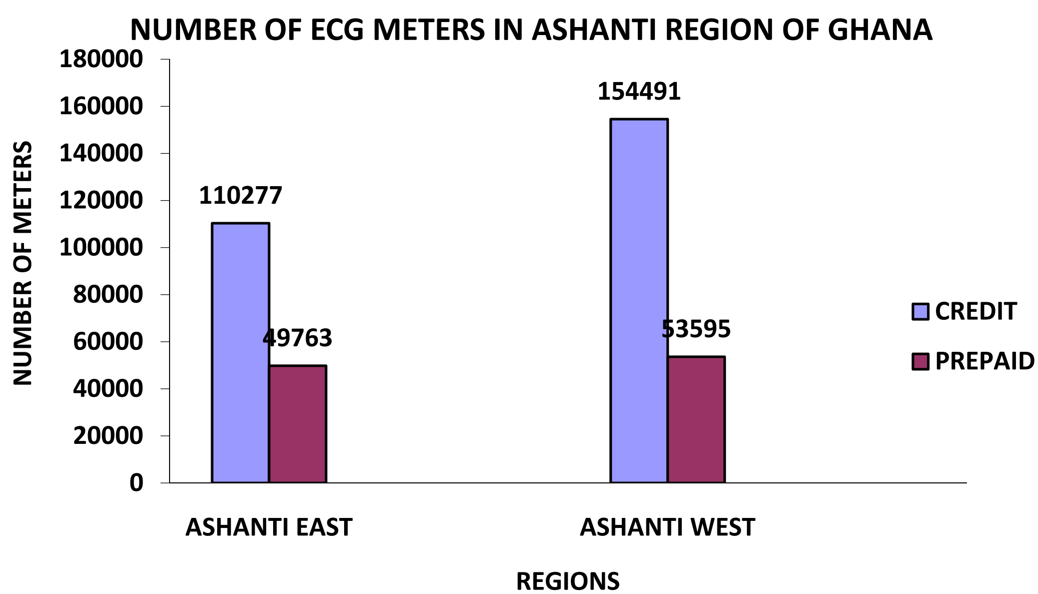


Figure 4.1. The number of meters in Ashanti East and West

It is noted from the graph (figure 4.1) that Ashanti West has the higher number of credit and prepaid with respect to Ashanti East. Customer population is denser in Ashanti West than Ashanti East because most of the commercial activities are located in this region.

4.1.2 Number of credit meters and Prepayment meters

From the tables of appendix 1-22 the total number of credit and prepaid meter users for the two regions are calculated is shown table 3.0 below.

Table 4.2 Number of Credit and Prepaid meters in Ashanti East Region

District	Prepaid meter	Credit meter	Total
Asokwa	8721	15868	24589
Ayigya	16087	21033	37120
Effiduase	0	13600	13600
Konongo	0	17589	17589
Kwabre	5035	11181	16216
Manhyia	19920	17278	37198
Mampong	0	13644	13644
SLT	0	89	89
Total	**49763**	**110282**	**160045**

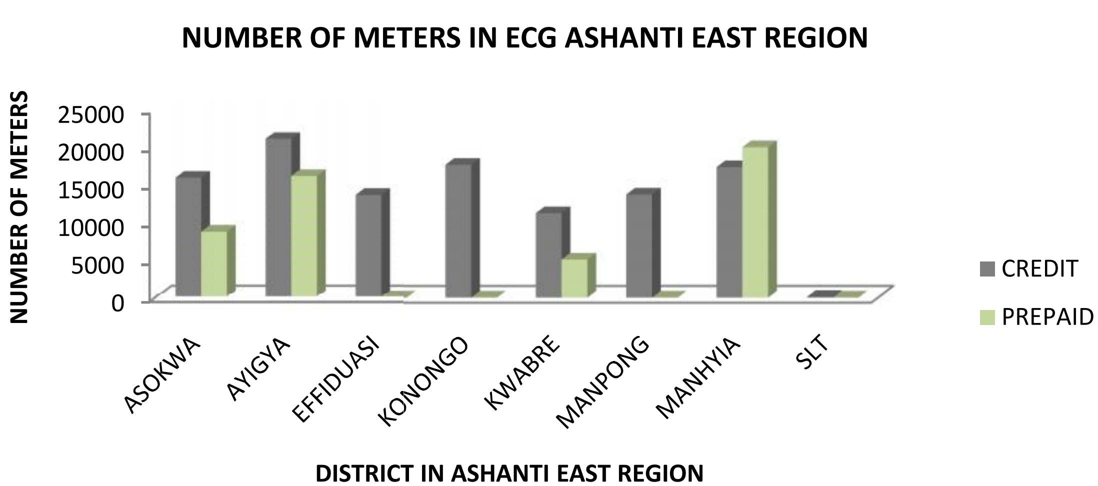
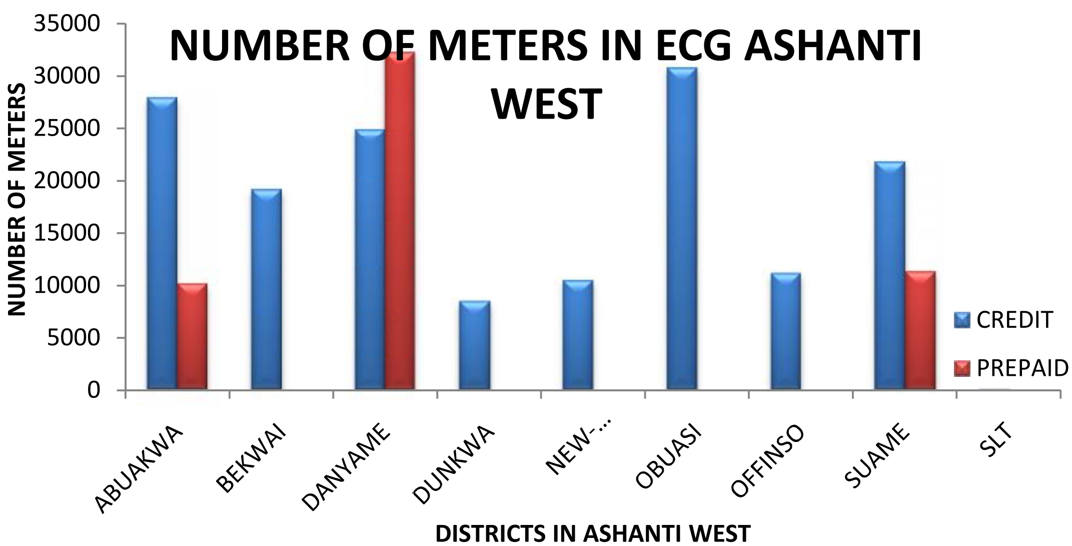


Figure 4.2 Number of credit and prepaid meter customers in Ashanti East Region

ECG has not yet introduced prepayment meters in Effiduasi, Konongo and Mampong as indicated above for reason known to ECG. Another obvious information from the chart is that where ECG has introduce prepaid meters, only Manhyia has the higher number of prepaid meters than credit meters. However SLT has limited number since Ashanti East is not industrially groomed.

Table 4.3 Number ECG meters in Ashanti West Region

	Credit meters	Prepaid meters	Total
Abuakwa	27955	10183	38138
Bekwai	19046	0	19046
Danyame	24870	32157	57027
Dunkwa	8472	0	8472
New-Eduabiase	10476	0	10476
Obuasi	30813	0	30813
Offinso	11156	0	11156
Suame	21669	11255	32924
SLT	34	0	34
Total	154491	53595	208086



Source: ECG Ashanti (12/03/11)

Figure 9.0. Number of meters in ECG Ashanti West Region

Prepayment meters have not yet been piloted in Bekwai, Dunkwa, New-Eduabiase, Obuasi and Offinso by ECG. With the implementation of prepayment in the other three districts only Danyame has the higher number of prepaid meters than credit meters

4.1.3 Relative Meter Percentages In Ashanti Region

This section of the chapter looks at the relative meter percentages of Ashanti Region as at December 2010.

From the above calculations

Total number of credit meters (Tc) = 264768

Total number of prepayment meters (Pc) = 103358

Total number of meters (Tm) = 368126

Percentage of credit meters for both east and west regions = $\left(\frac{Pc}{Tm}\right)*100\%$

= (264768/368126)*100%

= 71.9%

Percentage of prepaid meters for both east and west regions = $\left(\frac{Pc}{Tm}\right)*100\%$

= (103358/368126)*100%

= 28.1% as displayed in the fig.4.9 below.

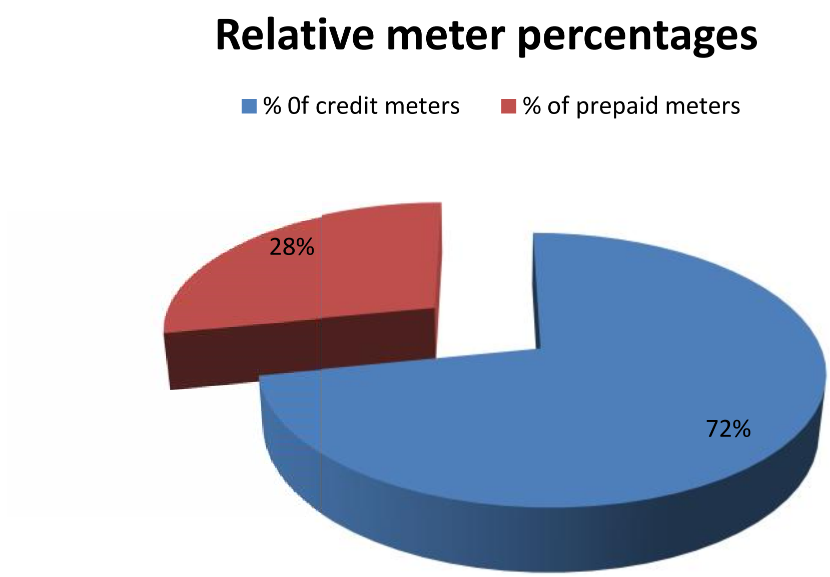


Figure 4.3 The relative meter percentages of Electricity Company of Ghana (ECG) customers in Ashanti East and West Regions

The relative meter percentages of Electricity Company of Ghana (ECG) customers in Ashanti East and West Regions (figure 10.0) shows that nearly 72% of the 368126 customers of Electricity Company of Ghana in Ashanti region are on credit meters and the remainder of 28% of this figure is on prepaid meters.

4.2 CONSUMPTION PATTERN AND HOW PREPAYMENT METERS HAS IMPACTED ON CUSTOMER –ENERGY USAGE IN ASHANTI EAST REGION

In this section the general consumption behavior of ECG customers in Ashanti East Region and specifically fifty sampled customers in Suame district of Ashanti West and fifty sampled customers in Asokwa District of Ashanti East is being investigated.

Data obtained from ECG was summarized to show how the behavior of the customer has been by analyzing

- ECG credit meter customers with prepaid meter customers consumption patterns in each districts Ashanti East under study for one year period when tariff were constant.
- Sampled ECG customers who have shifted from credit meters unto the prepaid for a period of one year when tariff remain unchanged.

4.2.1 Analysis of Consumption Pattern-Ashanti East Region

ECG percentage (%) savings made for each month = $\left[\frac{A-B}{A}\right]$*100 %

Where
A=Energy saved per credit customer
B=Energy saved per prepaid customer
In appendixes 1-22

JUNE (09)

A=125.41kWh

B=88.81kWh

A-B=36.60kWh

Therefore

ECG PERCENTAGE SAVING PER MONTH = [36.60/125.41]* 100%

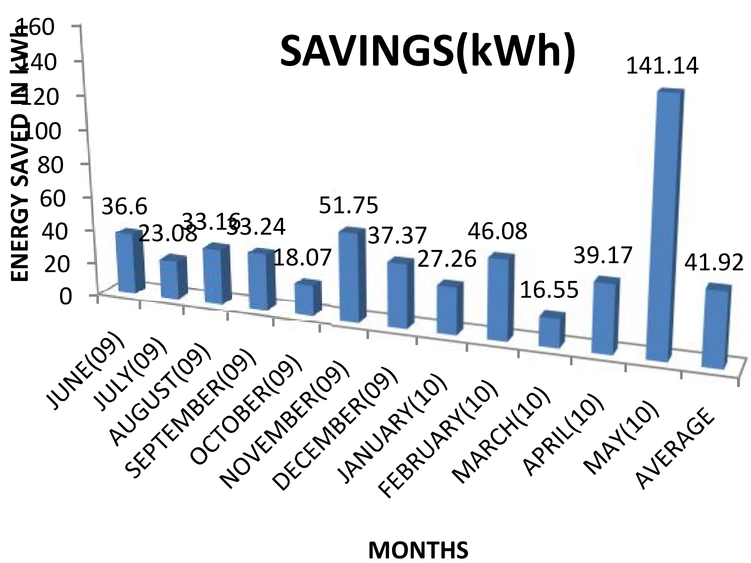
= 29.2%

Similarly the formula was applicable to the determination of the rest of the months as well as the annual savings shown in the table 5.0 below

Table 4.4 Analysis of Consumption Pattern-Ashanti East Region

MONTHLY	AVERAGE CREDIT CONSUMPTION (A)kWh	AVERAGE PREPAID CONSUMPTION (B)kWh	ENERGY SAVED (A-B)kWh	PERCENTAGE SAVINGS %
JUNE(09)	125.41	88.81	36.60	29.2
JULY(09)	122.01	98.93	23.08	18.9
AUGUST(09)	123.91	90.76	33.16	26.8
SEPTEMBER(09)	121.29	88.05	33.24	27.4
OCTOBER(09)	119.54	101.47	18.07	15.1
NOVEMBER(09)	135.08	84.05	51.75	38.3
DECEMBER(09)	119.11	81.74	37.37	31.4
JANUARY(10)	137.36	110.09	27.26	19.8
FEBRUARY(10)	144.19	98.10	46.08	31.9
MARCH(10)	129.82	113.27	16.55	13.0
APRIL(10)	146.27	107.10	39.17	26.8
MAY(10)	244.10	102.96	141.14	57.8
Total	**139.04**	**97.11**	**41.92**	**30.1**

ECG ASHANTI EAST MONTHLY ENERGY SAVINGS



Source: ECG ASHANTI (12/03/11)

Figure 4.4 Kilowatthour energy savings in Ashanti East from June 2009 to

It is clear from the above chart that there has been savings for each month within the period under study with the introduction of prepayment meters. The difference between the highest and the lowest savings recorded in May and March respectively is 124.59kWh. This wide difference could be as a result of or due to several factors including suppress demand affecting mostly prepaid meter users, vulnerability nature of the prepaid meters, errors in the recorded data within these two months among others.

Table 4.5. Monthly percentage savings and the annual average savings in Ashanti East Region

MONTH	JUNE(09)	JULY(09)	AUGUST(09)	SEPT.(09)	OCT.(09)	NOV.(09)	DEC.(09)
SAVINGS	29.2	18.9	26.8	27.4	15.1	38.3	31.4
MONTH	JAN(10)	FEB.	MARCH(10)	APRIL(10)	MAY(10)	TOTAL	
SAVINGS	19.8	31.9	13.0	26.8	57.8	30.1	

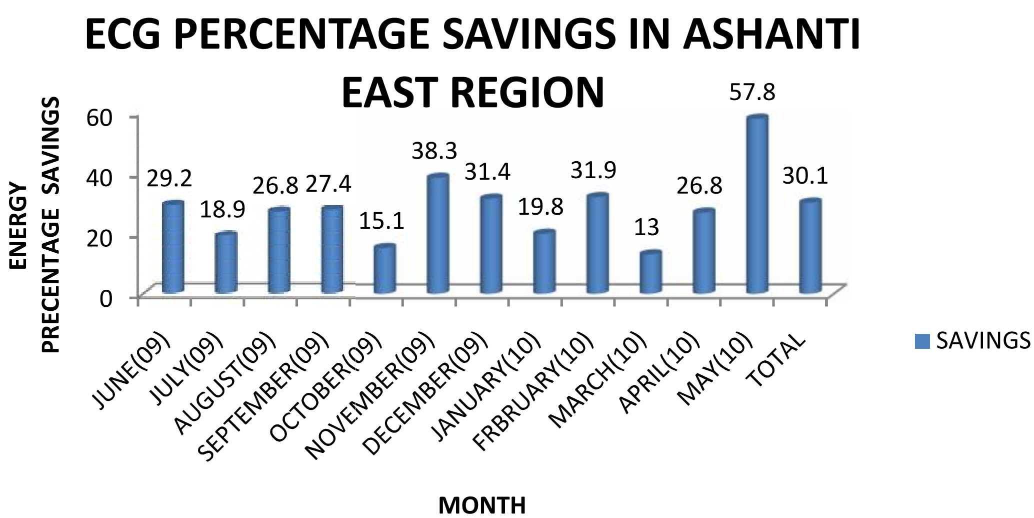


Figure 4.5 Monthly percentage savings and annual total savings for the period under study in Ashanti East Region

The highest percentages savings of 57.8% was in May 2010 and the lowest of 13.0% of savings was recorded in March 2010. The average annual savings of 30.1% was realized. This means that on the average 30.1% of the energy which were to have been supplied by ECG to customers in Ashanti east region between the period of June 2009 to May 2010 was saved by the introduction of prepayment metering system in the region.

4.2.2 Analysis of Consumption Pattern–sampled Customers

To satisfy ourselves how the prepaid system has helped the individual customer to reduce his/her energy consumption we further obtained the historical credit consumption records of fifty customers from Suame and eighty customers from Asokwa at the district level. We then conducted a direct interview among these randomly selected customers to obtain their monthly prepaid consumption for a period of twelve months.

4.2.2.1 Suame District-Ashanti West Region

Fifty sampled customers who were previously credit meter users and have moved unto the prepaid system after the introduction of prepayment, whose credit consumption records were generated at the district office were interviewed to obtained their prepaid consumption records for five months .Both records of these fifty sampled customers was when tariff remain unchanged. That is between January 2009 to May 2009 ,when they were using credit meters and also for the period between January 2010 to May 2010. From appendix 4.23,the table 9.0 was obtained

Table 4.6. Records of fifty individual customers in Suame interviewed in Ashanti West.

	Consumption before (credit) (kWh)	Consumption after(prepaid) (kWh)	Energy Saved (kWh)	Percentage savings %
Total	18490.58	11786.55	6704.03	36.26

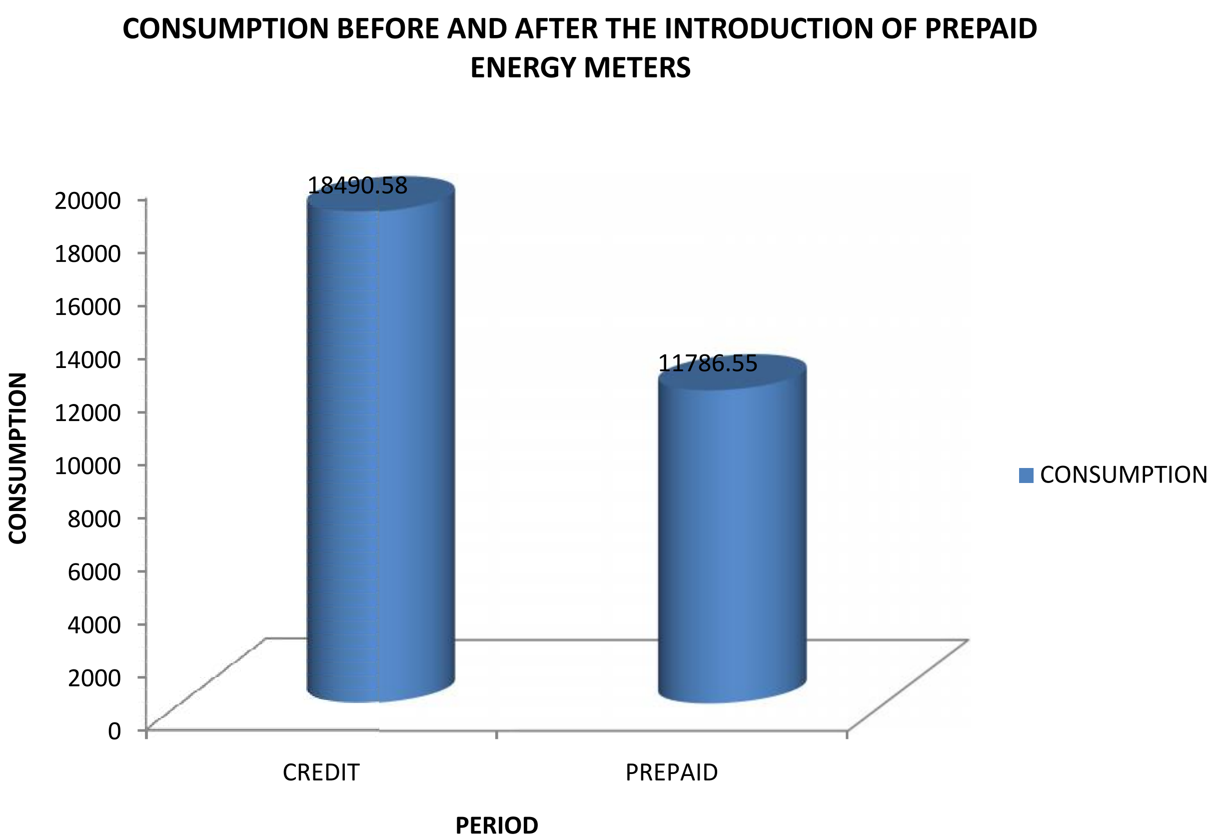


Figure 4.6 The total energy consumption of the fifty sampled customers in Suame District before and after the introduction of prepaid meters.

It is clear from the above graph that savings had been made after they have moved from credit meters to prepayment during the period. Savings made was 6704.03 kWh which is equivalent to 36.3% of their total consumption during the five month period when they were on credit meters.

4.2.2.2 Asokwa District-Ashanti East Region

Fifty sampled customers who were previously credit meter users and have moved unto the prepaid system after the introduction of prepayment, whose credit consumption records were generated at the district office were interviewed to obtained their prepaid consumption records for five months. Both records of these eighty sampled customers was when tariff remain unchanged. That is between June 2009 to October 2009, when they were using credit meters and also for the period between January 2010 to May 2010. From appendix 4.24, the table 4.7.0 was obtained.

Table 4.7. Records of the fifty individual customers in Asokwa interviewed in Ashanti East

	Consumption before (credit) (kWh)	Consumption after(prepaid) (kWh)	Energy Saved (kWh)	Percentage savings %
Total	12442.20	7690.49	4751.71	38.0

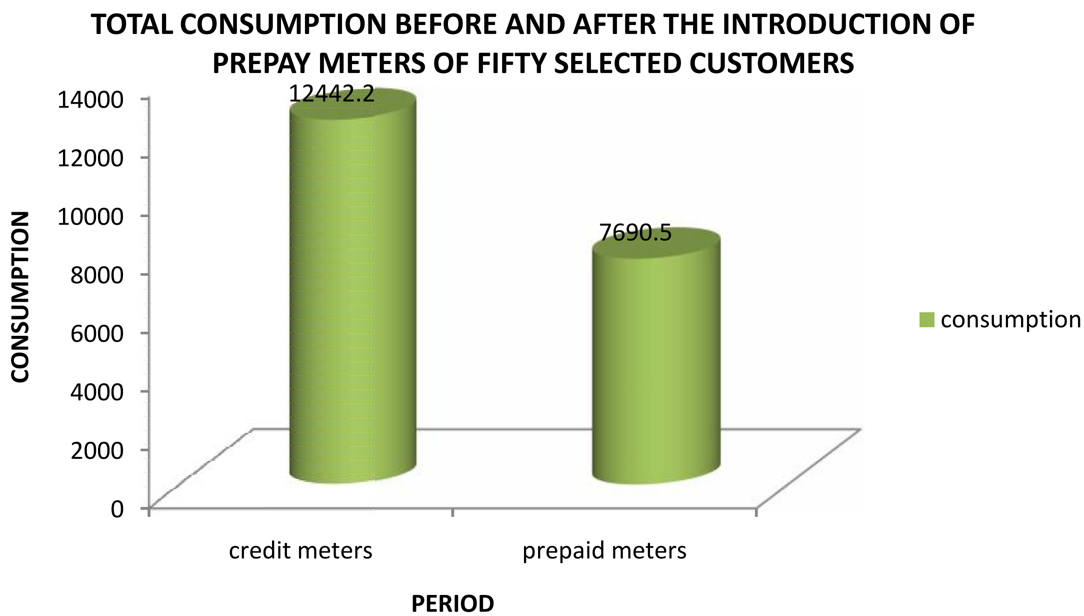


Figure 4.7 The total energy consumption of the fifty sampled customers in Asokwa district before and after the introduction of prepaid meters

It is clear from the above graph that savings had been made after they have moved from credit meters to prepayment during the period. Savings made was 4751.71kWh which is equivalent to 38.0 % of their total consumption during the five month period when they were on credit meters.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATION

5.1 INTRODUCTION

This research work is aimed at the impact of prepayment metering system on the customer - energy usage in Ghana .That is the researchers want to find out how the electrical energy prepayment meters have influence customer energy usage.

To be able to explore the topic extensively, the study was divided into five (5) comprehensive chapters. Even though the five chapters were independent, they were interrelated to ensure a presentation of a chronological report. Chapter one dealt primary with the general introduction of the research and it covered the background to the study, justification of the project, the objective as well as the methodology of the study. The second and the third chapters were devoted solely for the literature review. The chapter two dealt with the classes, benefits, implementation in Ghana and billing methods of the prepayment metering system. In chapter three, the general effects on the consciousness of customers on reducing energy leading to energy conservation and its benefits were discuss. The fourth chapter on the hand covered the empirical analysis and detailed discussions of the survey results. The last chapter, chapter five (5), gave a summary of how the research was structured, the findings made, limitations of the study and concluded with recommendations.

5.2 THE RESEARCH OBJECTIVES AND FINDINGS

As mentioned earlier in section1.3, the main aim of this research was to find out the impact the prepayment metering system has had on the customer energy usage in Ghana. The main objective was further broken into four (4) specific objectives. Objective number one (1) examined the literature review on prepayment metering system. The second specific objective was to obtain from Electricity Company of Ghana (ECG) the relative percentage of prepayment and conventional credit meters. The third specific objective was to get historical records of energy consumption for before and after the introduction of prepayment meters. The last specific objective was to document the consumption pattern and statistical analysis to show the extent to which the switch to prepayment metering has reduce energy usage cost savings.

5.3 SPECIFIC OBJECTIVES

5.3.1 To Review the literature on prepayment metering systems

The first objective was to conduct a critical review of literature on prepayment metering systems. The literature review indicated that there are four classes of prepayment meters. They are smart card, token, remote controlled and key prepayment meters. It also reveals that prepayment systems have benefited both the utility companies as well the individual customers. Again the review indicated that ECG first piloted the system in 1994 in Accra, Kumasi, and Tema. On the methods of billing the review indicates three methods which include electromechanical technology, communication technology and automatic reading.

Furthermore, in the literature it is indicated that the system's effect includes energy reduction leading to energy conservation and its associate benefits. Also prepayment has gained increased attention in the last several years. The primary reason customers switching from credit billing to prepayment almost always reduced their electricity consumption. Example Salt River Project report a 12.8% reduction in energy use when customers switch from credit to prepay [22]. Northern Ireland electricity says prepayment customers use 4.9% less electricity than average customer [23] and Oklahoma Electric Cooperative report that customers lowered consumption 13% after switching to prepayment [24].

5.3.2 To obtain from ECG the relative percentages of prepayment and conventional credit meter customers

The second specific objective (objective number 2) was to obtain from ECG the relative meter percentages of credit and prepay meters. From the analysis and results Ashanti Region has 72% of credit meters and 28% of prepay meters. The Region is divided into two ,Ashanti East with 79.4% credit meters and 20.6% prepay meter, and Ashanti West with 74.2% credit meters and 25.8% prepay meters.

5.3.3 To get the historical records of energy consumption for before and after introduction of prepayment meters

The third specific objective (objective number 3) was to get the historical records of energy consumption for before and after introduction of prepayment meters. The data was obtained and detailed analysis of it is attached to the report as appendix 1-24.

5.3.4 To document the consumption pattern and statistical analysis to show the extent to which the switch to prepayment metering has reduced energy usage; any energy cost savings.

The last specific objective (objective number 4) was to document the consumption pattern and statistical analysis to show the extent to which the switch to prepayment metering has reduced energy usage; any energy cost savings. From the analysis of the data, ECG Ashanti East as a utility provider has been able to save 41.92kWh per customer using prepaid meter (i .e 30.1%) of the energy it should have supplied to customers in the region after the introduction. The further studies on the randomly selected customers in Suame indicates that the individual customers were able to save 36.3% whiles in Asokwa it indicates that the individual customers saved 38.0% after switching unto the prepayment.

5.4 CONTRIBUTION TO KNOWLEDGE

As this research is aimed at the impact prepayment metering system has on the consumer energy usage its finding is believed would add positively to the already existing knowledge especially in developing countries like Ghana. The findings would also be useful to both government and non-governmental institutions including the utility companies and the individual consumer that wish take decision as to whether or not to implement the system.

5.5 RECOMMENDATIONS

The following recommendations are made with the conviction that they will go a long way to assist and improve the implementation of prepayment in Ghana. The Government should put all necessary administrative measures in place to ensure its successful implementation in all government agencies, department and educational institution in Ghana.

The Ministry of Energy and Ghana Standard Board should ensure that all energy meters that come into the system meet the international standards. The utility providers especially ECG should vigorously embark on customer education on the need for the system`s acceptance and to invest more to ensure its total implementation since it has a lot of benefits.

5.6 LIMITATIONS OF THE RESEARCH

As it has always been with most academic activities this research is not without limitations. Some of the limitations encountered during the entire research period are outlined below.

- The study area was limited to the Ashanti Region only and this could affect the generalizations of the findings.
- The utility staff feels reluctance to give out data since some information are very sensitive to be given out without authority from above.

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APPENDIX 4.1

ASH.EAST;MONTH,JUNE(09)			CREDIT METER				PREPAID METERS				
DISTRICT		BILLING GROUP	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GHC)	UNITS/CUSTOMER (KWH/CUST)A	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GHC)	UNITS/CUSTOMER (KWH/CUST)B	SAVINGS(A-B) /(kwh)/CUST
ASOKWA		1	1586	222523	30527.59	140.30	6667	709200	99288	106.37	33.93
		2	1911	269770	39444.54	141.17					
		7	3582	679444	90624.52	189.68					
		8	2126	358966	48951.27	168.85	1877	202628	28367.92	107.95	60.89
		13	6356	965809	136133.13	151.95					
	TOTAL		15561	2496512	345681.05	160.43	8544	911828	127655.92	106.72	53.71
MANHIA		3	8215	1331278	185642.74	162.05	16092	563977	78956.78	35.05	116.78
		12	6507	987987	137155.87	151.83					
		18	3954	308347	51489.8	77.98	5607	187993	26319.02	33.53	44.46
	TOTAL		18676	2627612	374288.44	140.69	21699	751970	105275.8	34.65	106.04
AYIGYA		4	8719	1142915	157210.58	131.08	6294	871385	121993.9	138.45	-7.36
		11	6047	751972	108343.53	124.35	1096	114605	16044.7	104.57	19.79
		15	2815	376312	52089.21	133.68	7262	789253	110495.42	108.68	25.00
		22	3049	476114	65461.1	156.15	1402	112751	15785.14	80.42	75.73
	TOTAL		20630	2747313	383095.42	133.17	16054	2172772	304188.08	135.34	-2.17
KWABRE		17	6149	1104467	147986.97	179.62	4783	655200	91728	136.99	42.63
		16	4071	408329	54258.46	100.30	725	109200	15288	150.62	-50.32
	TOTAL		10220	1512796	202245.43	148.02	5508	764400	107016	138.78	9.24
KONONGO		9	8118	787923	114323.96	97.06	0	0	0	0	0
		5	948	601907	88092.15	634.92	0	0	0	0	0
	TOTAL		17498	1389830	220416.11	79.43	0	0	0	0	0

FFIDUASI		10	6173	659491	91664.28	106.83	0	0	0	0	0
		6	7944	789016	112991.01	99.32	0	0	0	0	0
	TOTAL		14107	1448507	204655.29	102.68	0	0	0	0	0
MAMPONG		14	8881	783031	110502.79	88.17	0	0	0	0	0
		25	5173	456735	63796.38	88.29	0	0	0	0	0
	TOTAL		14054	1239766	174299.97	88.21	0	0	0	0	0
SLT(CBIS)		20	89	450327	99956.49	5059.85	0	0	0	0	0
GRAND TOTAL			110935	1.4E+07	2004637.4	125.41	51805	4600970	644135.8	88.81	36.60

(A-B),=36.60, A=125.41,B=88.81 X=110935, Y=51805

APPENDIX 4.2

ASH.EAST;MONTH,JULY(09)			CREDIT METER				PREPAID METERS				
DISTRICT		BILLING GROUP	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GHC)	UNITS/CUSTOMER (KWH/CUST)A	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GHC)	UNITS/CUSTOMER (KWH/CUST)A	SAVINGS(A-B) /(kwh)/CUST
ASOKWA		1	1586	245937	34315.81	155.07	6560	981586	137422.04	149.63	5.44
		2	1900	289561	42284.67	152.40					
		7	3543	639171	86751,22	180.40					
		8	2151	445623	56831.26	207.17	1867	327195	45807.3	175.25	5.15
		13	6351	287766	142164.67	45.31					
	TOTAL		15531	2578058	362347.72	165.99	8427	1308781	183229.34	155.31	10.69
MANHIA		3	8180	1284800	177522.69	157.07	16042	1012560	141758.4	63.12	93.95
		12	6492	984300	138049.77	151.62					
		18	3938	320653	53460.9	81.43	5585	337520	47252.8	60.43	20.99
	TOTAL		18610	2589753	369032.55	139.16	21627	1350080	189011.2	62.43	76.73
AYIGYA		4	8717	1174946	160278.01	134.79	6206	535611	74985.54	86.31	48.48
		11	6044	789210	114678.9	130.58	1087	142789	19990.46	131.36	-0.78
		15	2814	346605	47969.42	123.17	7262	551806	77252.84	75.99	47.19
		22	3037	459653	64025.81	151.35	1402	143189	20046.46	102.13	49.22
	TOTAL		20612	2770414	886952.14	134.41	15957	1373395	192275.3	86.07	48.34
KWABRE		17	8103	1107981	146780.33	136.74	4772	911220	127570.8	190.95	-54.21
		16	4094	432832	58593.44	105.72	723	151870	21261.8	210.06	-104.33
	TOTAL		12197	1540813	205373.77	126.33	5495	1063090	148832.6	193.46	-67.14
KONONGO		9	8205	813263	117901.77	99.12	0	0	0	0	0
		5	9538	644745	92727.13	67.60	0	0	0	0	0
	TOTAL		17743	1458008	210628.9	82.17	0	0	0	0	0

EFFIDUASI		10	6216	752856	106802.9	121.12	0	0	0	0	0
		6	9790	832962	117006.97	85.08	0	0	0	0	0
	TOTAL		14206	1585808	223809.87	111.63		0	0	0	0
MAMPONG		14	8906	707946	100463.17	79.49	0	0	0	0	0
		25	5193	508658	70893.47	97.95	0	0	0	0	0
	TOTAL		14099	1216604	171357.21	86.29	0	0	0	0	0
SLT(CBIS)		20	89	58070	129309.78	652.47	0	0	0	0	0
GRAND TOTAL			113087	13797528	2058811.9	122.01	51506	5095346	713348.44	98.93	23.08

(A-B),=23.08, A=122.01, B=98.93 X=113087, Y=51506

APPENDIX 4.3

ASH.EAST: August(09)			CREDIT METER				PREPAID METERS				
DISTRICT		BILLING GROUP	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GH₵)	UNITS/CUSTOMER (KWH/CUST)A	NO. OF CUSTOMERS	UNITS/ (kWh)	AMOUNTS (GH₵)	UNITS/CUSTOMER (KWH/CUST)B	SAVINGS (A-B) /(kWh)/CUST
ASOKWA		1	1579	238990	33570.81	151.3552882	6667	802969	112415.66	120.44	28.51
		2	1899	275260	39985.62	144.9499737					
		7	3566	613981	83511.88	172.1763881	1877	267656	37471.84	142.60	21.06
		8	2202	333986	45712.45	151.6739328					
		13	6320	1064909	152052.84	168.4982595					
	TOTAL		15566	2527126	354833.6	162.3490942	8544	1070626	149887.64	125.31	24.79
MANHYIA		13	8166	1323179	184491.47	162.0351457	16092	1226410	171697.4	76.21	80.04
		12	6481	972824	135412.98	150.1039963					
		18	3933	301922	50687.66	76.76633613	5607	408803	57232.42	72.91	3.86
	TOTAL		18580	2597925	370592.11	139.8237352	21699	1635213	228929.82	75.36	41.95
AYIGYA		4	8740	1209371	164949.57	138.371968	6294	467616	65466.24	74.30	64.08
		11	6048	713995	102752.99	118.0547288	1096	77036	10785.04	70.29	47.77
		15	2815	334165	45863.95	118.7087034	7262	545552	76377.28	75.12	43.58
		22	3043	468007	64368.27	153.7978968	1402	78836	11037.04	56.23	97.57
	TOTAL		20646	2725538	377934.78	132.0128839	16054	1169040	163665.6	72.82	63.25
KWABRE		17	8117	1112532	146972.14	137.0619687	4783	708896	99245.44	148.21	-11.15
		16	4133	410247	54941.23	99.2613114	725	118149	16540.86	162.96	-63.70
	TOTAL		12250	1522779	201913.37	124.3084898	5508	827046	115786.44	150.15	-37.43
KONONGO		9	8280	731059	104248.74	88.29214976	0	0	0	0	0
		5	9572	643017	92977.44	67.17687004	0	0	0	0	0
	TOTAL		17852	1374076	197326.18	76.97042348	0	0	0	0	0
EFFIDUASI		10	6303	656217	90380.05	104.1118515	0	0	0	0	0
		6	8193	903876	126781.43	110.3229586	0	0	0	0	0
	TOTAL		14496	1560093	217161.48	107.6223096	0	0	0	0	0

MAMPONG		14	8980	811028	114622.6	90.31492205	0	0	0	0	0
		25	5232	478673	66669.42	91.48948777	0	0	0	0	0
	TOTAL		14212	1289701	181292.02	90.7473262	0	0	0	0	0
SLT(CBIS)		20	89	491024	109229.64	5517.123596	0	0	0	0	
GRAND TOTAL			113691	14088262	1611090.6	123.9171262	51805	4701925	658269.5	90.76	33.16

(A-B), = 33.16, A=123.91, B=90.76 X=113691, Y=51805

APPENDIX 4.4

ASH.EAST;MONTH,SEPT(09)			CREDIT METER				PREPAID METERS				
DISTRICT		BILLING GROUP	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GHC)	UNITS/CUSTOMER (KWH/CUST)A	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GHC)	UNITS/CUSTOMER (KWH/CUST)B	SAVINGS(A-B) /(kwh)/CUST
ASOKWA		1	1580	225318	31098.46	142.61	6755	767641	107469.74	113.64	28.69
		2	1900	247793	36127.21	130.42					
		7	3590	559251	77974.62	155.78					
		8	2213	338813	46804.64	153.10	1881	255880	35823.2	136.03	20.07
		13	6312	1004516	143026.06	159.14					
	TOTAL		15595	2375691	335030.99	152.34	8636	1023521	143292.94	118.52	33.82
MANHIA		3	8177	1300065	179625.12	158.99	16101	1142191	159906.74	70.94	88.05
		12	6491	938387	130461.66	144.57					
		18	3932	305337	51568.08	77.65	5607	380730	53302.2	67.90	9.75
	TOTAL		18600	2543789	361654.86	136.76	21708	1522921	213208.94	70.15	66.61
AYIGYA		4	8782	1274926	169656.03	145.17	6324	492216	68910.24	77.83	67.34
		11	6052	730901	105660.4	120.77	1111	80036	11205.04	72.04	48.73
		15	2818	318498	44166.49	113.02	1401	84036	11765.04	59.98	53.04
		22	3158	508199	69573.58	160.92	7263	574252	80395.28	79.07	81.86
	TOTAL		20810	2832524	389056.5	136.11	16099	1230541	172275.74	76.44	59.68
KWABRE		17	8114	1283063	172593.9	158.13	4799	685353	95949.42	142.81	15.32
		16	4136	406992	54647.7	98.40	735	114226	15991.64	155.41	-57.01
	TOTAL		12250	1690055	227241.6	137.96	5534	799579	111941.06	144.48	-6.52
KONONGO		9	8308	803347	118303.18	96.70	0	0	0	0	0
		5	9623	602050	88510.5	62.56	0	0	0	0	0
	TOTAL		17931	1405397	206813.68	78.38	0	0	0	0	0

EFFIDUASI		10	6322	691648	97379.75	109.40	0	0	0	0	0
		6	8225	767327	108799.68	93.29	0	0	0	0	0
	TOTA L		14547	1458975	206179.43	100.29	0	0	0	0	0
MAMPONG		14	9023	745634	105318.03	82.64	0	0	0	0	0
		25	5256	473604	66915.15	90.11	0	0	0	0	0
	TOTA L		14279	1219238	172233.18	85.39	0	0	0	0	0
SLT(CBIS)		20	89	313956	69403.64	3527.60	0	0	0	0	0
GRAND TOTAL			114101	13839625	1967613.9	121.29	51977	4576562	640718.68	88.05	33.24

(A-B)=33.24, A=121.29, B=88.05 X=114101, Y=33.24

APPENDIX 4.5

ASH.EAST;MONTH,OCT.(09)			CREDIT METER				PREPAID METERS				
DISTRICT		BILLING GROUP	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GHC)	UNITS/CUSTOMER (KWH/CUST)A	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GH)	UNITS/CUSTOMER (KWH/CUST)B	SAVINGS(A-B) /(kwh)/CUST
ASOKWA		1	1580	236739	32901.3	149.83	6809	931938	130471.32	136.87	25.3
		2	1900	286805	42069.65	150.95					
		7	3623	675752	91847.4	186.52					
		8	2231	407262	56431.06	182.55	1888	310646	43490.44	164.54	12.41
		13	6321	1083062	155016.8	171.34					
	TOTAL		15655	2689620	378266.2	171.81	8697	1242584	173961.76	142.88	28.93
MANHYIA		3	8226	1357580	187790.1	165.04					
		12	6504	1030885	144720.4	158.50	5610	439153	61481.42	78.28	83.72
		18	3934	319437	52895.18	81.20	16104	1317460	184444.4	81.81	-0.61
	TOTAL		18664	2707902	385405.7	145.09	21714	1756614	245925.96	80.90	64.19
AYIGYA		4	8806	1399714	191076.2	158.95	1401	101633	14228.62	72.54	86.41
		11	6060	818618	119241.2	135.09	1111	100033	14004.62	90.04	45.05
		15	2817	355467	48974.3	126.19	6327	604998	84699.72	95.62	30.56
		22	3061	497056	68497.76	162.38	7262	705831	98816.34	97.20	65.19
	TOTAL		20744	3070855	427798.5	148.04	16101	1512495	211749.3	93.94	54.10
KWABRE		17	8114	1323403	178001	163.10	4801	659605	92344.7	137.39	25.71
		16	4146	431599	57483.55	104.10	734	109934	15390.76	149.77	-45.67
	TOTAL		12260	1755002	235484.6	143.15	5535	769539	107735.46	139.03	4.12
KONONGO		9	8344	805719	116361.8	96.56	0	0	0	0	0
		5	9644	672952	96734.75	69.78	0	0	0	0	0
	TOTAL		17988	1478671	213096.5	82.20	0	0	0	0	0
EFFIDUASI		10	6322	718247	100267.3	113.61	0	0	0	0	0

		6	8224	915742	128903.4	111.35	0	0	0	0	0
	TOTAL		14546	1633989	229170.6	112.33	0	0	0	0	0
MAMPONG		14	9048	847484	120584.8	93.67	0	0	0	0	0
		25	5269	532123	73833.85	100.99	0	0	0	0	0
	TOTAL		14317	1379607	194418.6	96.36	0	0	0	0	0
SLT(CBIS)		20	89	421691	93600.54	4738.10	0	0	0	0	0
GRAND TOTAL			114263	13658666	1944145	119.54	52047	5281232	739372.48	101.47	18.07

(A-B),=18.07, A=119.54 B=101.47 X=114263, Y=52047

APPENDIX 4.6

ASH.EAST;MONTH,NOV(09)			CREDIT METER				PREPAID METERS				
DISTRICT		BILLING GROUP	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GHC)	UNITS/CUSTOMER (KWH/CUST)A	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GHC)	UNITS/CUSTOMER (KWH/CUST)B	SAVINGS(A-B) /(kwh)/CUST
ASOKWA		1	1581	268879	37585.08	170.07	6828	497463	69644.82	72.86	90.97
		2	1905	298764	44123.27	156.83					
		7	3664	801897	111261.35	218.86					
		8	2253	442103	60772.71	196.23	1890	165821	23214.94	87.74	103.97
		13	6332	1185296	169636.48	187.19					
	TOTAL		15735	2996939	423378.89	190.46	8718	663284	92859.76	76.08	114.38
MANHYIA		3	8281	1642386	232397.79	198.33	16117	1173916	164348.24	72.84	85.2
		12	6523	1030885	144720.43	158.04					
		18	3944	362020	60887.67	91.79	5611	391306	54782.84	69.74	22.05
	TOTAL		18748	3035291	438005.89	161.90	21728	1565222	219131.08	72.04	89.86
AYIGYA		4	8879	1655023	229799.05	186.40	6335	565539	79175.46	89.27	97.13
		11	6079	916129	133981.52	150.70	1114	90257	12635.98	81.02	69.68
		15	2842	434381	60686.09	152.84	1402	98256	13755.84	70.08	82.76
		22	3114	642639	89963.71	206.37	7260	659795	92371.3	90.88	115.49
	TOTAL		20906	3648172	514430.37	174.50	16111	1413847	197938.58	87.76	86.75
KWABRE		17	8197	1539149	209335.78	187.77	4806	632020	88482.8	131.51	56.26
		16	4163	534588	71984.8	128.41	744	105337	14747.18	141.58	-13.17
	TOTAL		12360	2073737	281320.58	167.78	5550	737356	103229.84	132.86	34.92
KONONGO		9	8358	860112	123037.27	102.91	0	0	0	0	0
		5	9657	640407	92054.73	66.32	0	0			

	TOTAL		18015	1503519	215092	83.46	0	0	0	0	0
EFFIDUASI		10	6361	804579	111813.57	126.49	0	0	0	0	0
		6	8347	1147201	158207.41	137.44	0	0	0	0	0
	TOTAL		14708	1951780	270020.98	132.70	0	0	0	0	0
MAMPONG		14	9060	905617	128701.68	99.96	0	0	0	0	0
		25	5280	525763	73714.8	99.58	0	0	0	0	0
	TOTAL		14340	1431380	202416.48	99.82	0	0	0	0	0
SLT(CBIS)		20	92	467040	103875.45	5076.52	0	0	0	0	0
GRAND TOTAL			114904	15604339	2233448.64	135.80	52107	4379709	613159.26	84.05	51.75

(A-B),=51.75, A=135.08, B=84.05 X=114904, Y=52107

APPENDIX 4.7

ASH.EAST;MONTH,DEC(09)			CREDIT METER				PREPAID METERS				
ISTRICT		BILLING GROUP	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GHC)	UNITS/CUSTOMER (KWH/CUST)A	NO. OF CUSTOMERS	UNITS/ (KWH)	AMOUNTS (GHC)	UNITS/CUSTOMER (KWH/CUST)B	SAVINGS(A-B) /(kwh)/CUST
SOKWA		1	1585	230642	32070.81	145.52	6843	534175	74784.5	78.06	67.46
		2	1906	245114	35671.78	128.60					
		7	3671	670516	92287.17	182.65					
		8	2256	440522	62485.26	195.27	1892	178059	24928.26	94.11	88.02
		13	6340	1071371	154519.6	168.99					
	TOTAL		15758	2658165	377034.62	168.69	8735	712234	99712.76	81.54	87.15
ANHIA		3	8283	1259322	175966.79	152.04	16124	1391138	194759.32	86.28	55.19
		12	6487	849069	117484.78	130.89					
		18	3944	347144	57892.73	88.02	5610	463713	64919.82	82.66	5.36
	TOTAL		18714	2455535	351344.3	131.21	21734	1854851	259679.14	85.34	45.87
YIGYA		4	8863	1505731	208745.3	169.89	6337	549360	76910.4	86.69	83.20
		11	6080	897427	132214.24	147.60	1120	90060	12608.4	80.41	67.19
		15	2837	350623	48617.68	123.59	7261	640920	89728.8	88.27	35.32
		22	3135	549697	76127.92	175.34	1402	93060	13028.4	66.38	108.97
	TOTAL		20915	3303478	465705.14	157.95	16120	1373395	192275.3	85.20	72.75
WABRE		17	8198	1359595	183684.13	165.84	4814	275985	38637.9	57.33	108.52
		16	4164	401426	54002.88	96.40	744	45998	6439.72	61.83	34.58
	TOTAL		12362	1761021	237687.01	142.45	5558	321983	45077.62	57.93	84.52
ONONGO		9	8381	841914	120501.09	100.46	0	0	0	0	0
		5	9661	734182	106419.89	75.99	0	0	0	0	0
	TOTAL		18042	1576096	226920.98	87.36		0	0	0	0

FFIDUASI		10	6363	792239	110795.04	124.51	0	0	0	0	0
		6	8351	784576	113430.31	93.95	0	0	0	0	0
	TOTAL		14714	1576815	224225.35	107.16	0	0	0	0	0
AMPONG		14	9075	958759	137345.61	105.65	0	0	0	0	0
		25	5278	571146	80873.97	108.21	0	0	0	0	0
	TOTAL		14353	1529905	218219.58	106.59	0	0	0	0	0
LT(CBIS)		20	93	406652	90298.52	4372.60	0	0	0	0	0
RAND OTAL			114951	1.4E+07	1964514.5	119.11	52147	4262463	596744.82	81.74	37.37

(A-B),=37.37, A=119.11, B=81.74 X=114951, Y=52147