THE COST- EFFECTIVENESS OF NED PROVIDING METERS TO EACH TENANT IN COMPOUND HOUSES IN NORTHERN AREA

by

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A Thesis submitted to the Institute Of Distance Learning, Kwame Nkrumah University of Science and Technology in partial fulfillment of the requirements for the degree of

COMMONWEALTH EXECUTIVE MASTERS OF BUSINESS ADMINISTRATION

OCTOBER 2011

DECLARATION

I hereby declare that this submission is my own work towards the Executive Masters Of Business Administration and that, to the best to my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

Separate metering is very dear to tenants of compound houses and a challenge to electricity utilities, particularly the Northern Electricity Department (NED). The study investigated the financial implications of installing meters for individual tenants of compound houses in Northern Area of NED. The study used analysis of variance (ANOVA) model to examine the consumption patterns of compound house accounts over time and from station to station. It was realized that tenants increased their consumption upon provision of separate meters, and that the increase was not as a result of time or place. A community survey was undertaken. The result of the survey on consumption conflicted with that of the ANOVA study. It could be that the respondents were of the view that their consumptions were reduced when they were given separate meters. This was probably based on assumption and not by serious consideration. The effect of the PURC tariff structure on the billing was examined. It was realized that in 58.6% of the sample, the amount was lower when the consumption was shared before calculation of the bill, than when the bill was computed before sharing it among tenants. Cost- benefit analysis revealed that a substantial revenue gain to Northern Area is achieved through separate metering. The net benefit in providing tenants with prepaid meters is higher at GH¢2,813,253.71. The inertia in getting 472,500 meters for this purpose are the capital cost and the fact that the department (NED) will need to take similar measures in other Areas.

ACKNOWLEDGEMENT

I wish to express my gratitude to Mr. Wayo Mahama, Finance Officer, Tamale Polytechnic, who was my Supervisor, for not only supervising the work but also giving me the necessary encouragement. Further, I acknowledge the help given me by Mr. Samuel Tabiri, Commercial Manager, Ghana Water and Sewerage, for his useful suggestions. I am also grateful to various fellow staff for the assistance they offered me. I highly appreciate the sacrifice and encouragement from my family that enabled me to complete this work. Finally, the strength and motivation for this research have come from God to Whom I am grateful.

Francis Babereyir

DEDICATION

To my dear wife, Mrs. Martha Gbeedem Babereyir and my children – Daniel Mwinsor Babereyir, Blaise Bonoyang Babereyir and Rose Vekumwin Babereyir with special love.

and also

To my dear mother, Basilia Mwinyal Babereyir and sister, Mrs. Jane Babereyir Doghle.

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CHAPTER ONE

INTRODUCTION

1.1.0 Historical Background of Northern Electricity Department (NED)

NED was established in April 1987 from the Electricity Company of Ghana (ECG) to supply power to the Northern parts of Ghana. The Volta River Development (Amendment) Law, 1987 (PNDCL 171) was passed to enable the Volta River Authority (VRA) to enter the distribution market after it extended electricity to the North. Thus, NED became a department of VRA. NED covers about 64% of the geographical area of Ghana and operates in six of the ten regions of the country. The NED customer population as at the year 2010 stands at about 300,000. (VRA/NED, 2010)

The boundary between NED and ECG is also the boundary between the Ashanti and Brong Ahafo regions of Ghana. However some parts of the Volta and Ashanti regions are being supplied electricity by NED.

NED was originally started as three operational areas namely Upper Area, Northern Area and Brong-Ahafo Area. In 1995 however, the Upper Area was divided into Upper East and Upper West Areas. In 2003 the Brong-Ahafo Area was also further divided into two areas, Sunyani and Techiman. This study is focused on Northern Area.

The Northern Area of NED covers an operational area encompassing the political Districts of Tamale, Yendi, Zabzugu/Tatale, Savelugu/Nantung, Gushegu, Saboba, Chereponi, Nanumba North, Nanumba South, Gonja East, Gonja Central, and Gonja West all in the Northern Region of Ghana and

Nkwanta and Kete Krachi Districts of the Volta Region of Ghana. The total area covered is estimated at about 174, 400 sq. kilometres.

1.2.0 Revenue Generation

The main sources of funding for NED's activities are the VRA, donor agencies and internally generated revenue. The main source of internally generated revenue is through power sales. The Commercial Section in Northern Area is responsible for the billing of customers.

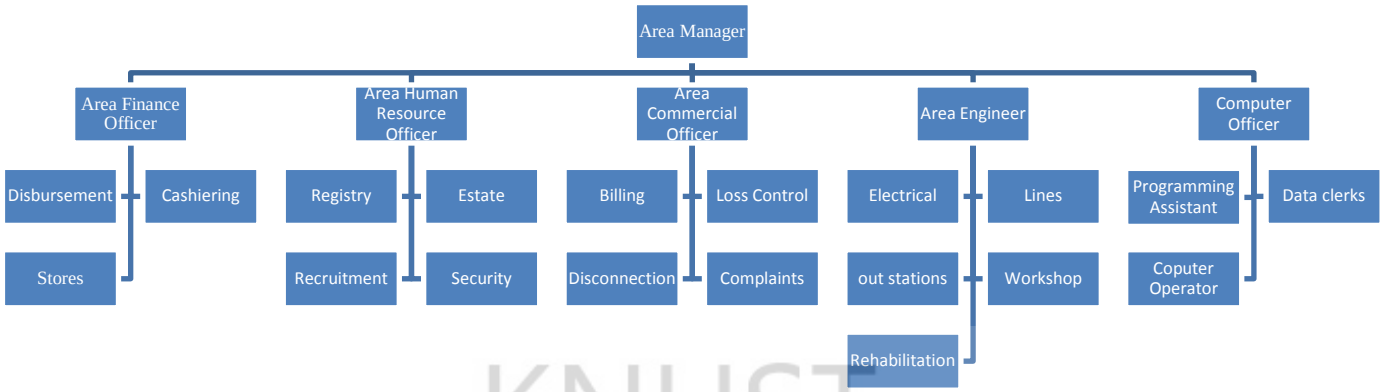
Bills are prepared 12 times in a year, that is, once a month for both metered and unmetered customers. For the metered customers billing is based on actual readings from customer's meters whiles unmetered customers are billed according to estimated consumption based on factors such as number of gadgets in a customer's premises. Bills are prepared according to tariffs approved by the Public Utility Regulatory Commission (PURC).

As at April 2011 the customer population of Northern Area was 95,500. Of these 88,392 had working meters while 7108 were not metered.

1.3.0 Profile of the Northern Area

The northern Area is comprised of five functional sections- the Commercial, Management Information Service, Technical, Finance and Human Resource, reporting to an Area Manager. It carries out its operations in the districts through its staff stationed in the districts. Its operational centre is in Tamale from where the out stations are supported. Figure 1 shows the organizational structure of Northern Area.

Figure 1.1: Organizational Structure Of Northern Area



Source: NED 2010 Annual Report

Operations are carried out through a distribution network of sixteen (16) sub- transmission lines/feeders at 34.5 kV, 30 kV, 20 kV, 11 kV and Low Voltage lines at 415 Volts. The sixteen sub- transmission feeders emanate from 161 kV transmission grid substations (bulk supply substations) at Tamale, Yendi and Sawla.

The Tamale Substation supplies 34.5 KV to Nawuni GWCL main pumping station for the Tamale Metropolis located at a distance of about 60 Km. Two shield wire schemes are also supplied from the Tamale Substation, 30 kV as far as Buipe in the Central Gonja district, a distance of about 105 Km and 20 kV to the Savelugu/ Nantung district, a distance of about 75 Km.

The Sawla Substation supplies 34.5 kV to the West Gonja district on a line length of about 60 Km. The Yendi Substation supplies Gushegu, Saboba, Zabzugu, the Yendi township, Nanumba, East Gonja, Nkwanta and Kete Krachi districts on five feeders. A summary is found in fig 2.

Table 1.1: Northern Area Sources of Supply

SOURCE	FEEDER	SUPPLY VOLTAGE (KV)	LENGTH (KM)	DESTINATION
TAMALE	28F2B	11	3.58	TAMALE
	28F3B	11	37.0	TAMALE
	28F4B	11	19.5	TAMALE
	28F6B	11	18.8	TAMALE
	28F7B	11	12.0	TAMALE
	28F8B	11	7.45	TAMALE
	28F9B	11	14	TAMALE
	28F11B	11	18	TAMALE
	28F1Y	34.5	37.8	NAWUNI
	28F4Y	20	82	SAVELUGU
	28F5Y	30	105	BUIPE
SAWLA	38F4Y	34.5	60	DAMONGO
YENDI	35F1Y	34.5	65	GUSHEGU
	35F2Y	34.5	72	SABOBA
	35F3Y	34.5	56	ZABZUGU
	35F4Y	34.5	17.4	YENDI
	35F5Y	34.5	360.	KRACHI

Source: NED Monthly Report for June 2010

1.4.0 The Current Operations of Northern Area

The mission of NED is to supply quality electricity, reliably, efficiently, safely and sustainably to meet customer demand and stakeholder expectations in Ghana and the West African sub region.

To achieve this mission an electrical network of sub- transmission and distribution system is maintained and operated in the Area. In the Tamale metropolis networks that were inherited from ECG have deteriorated. The Metropolis has also become denser and enlarged, and is being supplied by aged distribution lines. Northern Area thus applies itself to rehabilitating and upgrading these aged lines and transformers. This is possible through grants from institutions such as the World Bank, Japan International Cooperation Agency (JICA) and Swedish Aid. It also extends its networks to new developing suburbs in various towns as well as connects new supply services to individual applicants. New networks are added periodically by the Ministry of Energy through its Self- Help Electrification Programme (SHEP).

Northern Area uses prepayment metering in its major towns on a pilot basis to improve its revenue collection. Traditionally revenue collection is boosted through disconnection exercises.

1.5.0 Problem statement

Metering of electricity consumption in multi- tenant accommodation, known as compound houses in Northern Area of NED is often through a shared meter. Such a meter usually serves about two or more tenants in these compound houses. The monthly electricity bills are shared by these tenants

according to an agreed point system. The arrangement by which tenants contribute to pay for the monthly electricity bill of the house needs much to be desired by most tenants. Often the lighting points and sockets are counted as the bases for determining the number of points that a tenant consumes, and the bill is shared to the ratio of the points of all the tenants. This is the case despite the fact that appliances used at these points do not have the same ratings. The number of points that a tenant has is not related to the units of electricity it consumes. A tenant could have points that consume less electricity than those of other tenants. For instance a 100W bulb may be used by one tenant where as another may use a 40W bulb per point. Some tenants will have appliances that other tenants cannot afford. Furthermore, the frequency of use of electricity varies widely among tenants.

As a result of the lack of equity in sharing of the bills and the lack of trust among co-tenants and satisfaction for the billing process, many tenants prefer to have a meter to themselves. With the general perception that it is difficult to obtain a separate meter from the utility companies, these families resort to meter tampering. Northern Area recovers many faulty meters in the field daily. Where there is evidence that a customer is responsible for the damage of the meter, he/she is surcharged with the cost of the meter and an estimated cost of lost energy since by implication there was power theft.

The meter is the property of the service provider that is the Northern Electricity Department (NED). The electricity utility company is unable to provide meters for each tenant in a compound house and identifies a compound building as a single entity. NED has a contractual agreement with only the landlord. This is because meters are expensive as a result of which

some houses are not even metered. Revenue from the inadequate tariffs could hardly enable NED to purchase meters in such numbers to cater for each tenant.

However the request for separate meters is on the increase year by year as people begin new families and economic times get hard. Northern Area receives an average of six applications for separate meters daily. About 50% of these applications meet the conditions and get approved. Consignments of meters are supplied to the Area from time to time on an irregular basis. However, the stores always run out of stock before new consignments arrive. The period of unavailability of meters is often long and this means that even new service applicants get connected on flat rate, without a meter from time to time. During such periods, separate meter applications are not honoured. Therefore, the demand for separate meters is never satisfied in the Area. This study therefore examined the cost effectiveness of providing each tenant with meters.

Ghana has no redundancy in electric generation and often runs into energy deficits when the hydro plants do not have adequate water to generate electricity. Energy conservation is therefore dear to the nation. However,` the metering arrangement in compound houses might not encourage energy conservation. Since tenants share the electricity bill, there is therefore no incentive to reduce consumption. It is often perceived that a neighbour might not do so and yet the bill will be shared irrespective of this. Efforts at electricity conservation in such situations are impracticable. Due to the accumulation of energy consumed from the tenants, it is often said that total energy consumed in the month moves into the higher tariff bracket, making

such tenants worse off. As a result many meters are being damaged or bypassed by customers who think that the cost of electricity is high.

Since NED is unable to provide separate meters to individual tenants of any one compound house, the separate meters could be given to specified smaller groups of tenants, say two or three tenants each. Many more tenants would have been satisfied or pacified with the few meters provided. Providing the meters to individual tenants does not quickly reduce the demand for separate meters. In such a case until all the tenants of a compound house are provided with meters, the need for meters still exists in that house.

1.6.0 Objectives:

1.6.1 General Objective:

The study will investigate the financial implications of installing meters for individual tenants of compound houses in Northern Area.

1.6.2 Specific Objectives:

- To determine whether the tariff structure favours the utility company (NED) or the tenants of compound houses due to shared metering.
- To evaluate the cost and benefits of providing each household with meters.
- To determine consumption patterns over time of individual tenants when each is provided with a meter.
- To find out differences in consumption patterns from station to station.

1.7.0 Hypothesis

There are three effects on patterns of consumption in compound houses with separate meters;

1. Separation from parent meter
2. Consumption behaviour changes in a period of 1 year
3. Tenant consumption behaviour differences as a result of differences in location

The second and third issues were studied by Analysis of Variance (ANOVA) and the results were applied on the first effect. The hypotheses were postulated as follows:

Primary Hypothesis :

H0: there is no difference in patterns of consumption with time among compound houses.

H1: differences exist in patterns of consumption with time.

Secondary Hypothesis :

H0: there is no difference in consumption patterns from location to location in compound houses.

H1: differences exist in consumption patterns from location to location.

If there were no differences within 5% significance level, then an increase in consumption would be due to the separation from the parent meter.

1.8.0 Relevance of Study

1. Meters are expensive. A study of this kind is required in arriving at a decision on providing all tenants of compound houses with meters.
2. Separate metering will expose the true level of customer population.
3. Shared metering cause conflicts in compound houses. The various dimensions conflicts can take cannot be pre-determined. Provision of meters to individual tenants would improve inter- tenant relationship.
4. If all tenants were provided with separate meters the incidence of power theft would be greatly reduced.
5. Conservation of electrical energy is important in Ghana based on the fact that there was a shortfall in the generation capacity of electric plants in the country in the recent past. If energy were conserved when all tenants in compound houses were provided with meters the idea would form one of the options of conservation of energy.
6. The study will also provide a basis for further research work and studies into this subject matter.

1.9.0 Scope of study

The research was conducted within the Northern Area of NED. The data was obtained from the NED customer billing management system (CBMS). A sample of accounts of compound houses from different localities was randomly selected and a questionnaire administered.

1.10.0 Limitation

The CBMS was installed as a system that satisfied the Y2K compliance, therefore only data after the year 2000 might be available. The accuracy of the study was limited by the accuracy of the billing process and

reliability of the meters. The data was also dependent on the integrity and honesty of the meter reading staff. Other issues that could introduce errors into the data include tenants not being law abiding, data input errors and truthfulness of tenants in responding to survey.

1.11.0 Organisation of the thesis

Chapter one of this document presented the research proposal including the research problem. The literature on experiences and practices elsewhere was reviewed in chapter two. The research methodology which linked the data collected to the conclusion was discussed in chapter three. Chapter four of this study analysed the data and discussed the results. While chapter five dealt with the conclusion and recommendations of the research.

CHAPTER TWO

LITERATURE REVIEW

2.1.0 Concept of a Compound House

According to (Jorgen et al, 2007) a compound house, apartment or multi- tenant house is one which has many households (tenants) sharing a number of resources such as water and electricity supplies and washrooms. In Ghana tenancy is achieved through signing of a Tenancy Agreement, renewable upon expiry, to be provided with a specific number of rooms for a specified period at an agreed cost. The total cost of a period often has to be paid in advance before commencement of occupancy. A tenant can be ejected within the tenancy regulations or given notice to vacate his rooms for a purpose.

Multi- tenant accommodation is not only common to residential buildings, but is also applicable to commercial buildings with similar conditions of tenancy.

Compound houses represent good value for money, cost little to build, suit traditional inheritance patterns, allow independent life at low cost, and allow sharing of services with a finite and known group. (Jorgen et al, 2007).

There are some disadvantages in living in compound houses. Privacy can be a problem in the traditional compound house. As observed by (Jorgen et al, 2007), although in-room visual privacy can be good, sound travels easily among the rooms. There is also much overlooking of the courtyard and no-one can have a visitor without all residents knowing and comments being made. Many household activities take place in the courtyard because of lack

of space in the room or the need for good air movement, particularly for cooking and pounding starchy staples. (Jorgen et al, 2007).

Open spaces in the house are not always common ground. There are obviously many points at which conflict can occur and sharing often poor services is undoubtedly one of the issues influencing households to prefer individual living. (Jorgen et al, 2007).

2.2.0 The concept of metering compound houses.

After wiring a compound house, the landlord buys an application form for supply of electricity from NED offices and completes the form. The form requires that the name and address of the applicant are taken together with the location of the house. Since the wiring is more or less often done bringing all the circuits to one distribution board, the electricity is supplied to the board with one meter. Once in a while some developers wire their semi-detached houses for more than one meter i.e. with more than one distribution board.

Thus in the case of one meter, it serves all the tenants that occupy rooms in that house. Therefore monthly electricity bills are often shared by the tenants. This is often supervised by a utility chairman or the landlord of the house.

In some countries electricity bills are factored into the rent paid by tenants whilst one meter is used to capture the electricity consumption of the house. The landlord therefore directly pays off the electricity bills. In Canada many apartment and condominium buildings currently have only one meter for the entire building, with power bills averaged among residents regardless of how much power they waste or conserve. (Spears, 2004). At the

commercial building in Higashi-Shinsaibashi in Chuo Ward Japan, the landlord pays the electric bill for the entire building and then collects payment from individual tenants. (Yomiuri, 2009, September 4). In Texas, the allocation of central system utilities costs or non- sub- metered (master metered) utilities costs to tenants is based on one or a combination of the following methods.

(i) the total square footage living area of the dwelling unit as a percentage of the total square footage living area of all dwelling units of the apartment house and all heated and/or air conditioned common areas. This percentage shall be stated in the rental agreement for each dwelling unit; and

(ii) the individually metered or sub-metered utility usage of the dwelling unit as a percentage of the sum of the individually metered or sub-metered usage of all dwelling units. (PURC, 25.141).

2.3.0 The contribution of individual tenants to electricity bills.

In Ghana bills apportioned to individual tenants by landlords is not bound by law or regulation. Each house fashions out a method of apportioning the electricity bills. The common method used is to count the number of socket and lighting points of a tenant and apportion the bill in ratio to the total points.

A similar arrangement exists in the Texas PURC regulations. The total square footage living area of the dwelling unit as a percentage of the total square footage living area of all dwelling units of the apartment house and all heated and/or air conditioned common areas. This percentage shall be stated in the rental agreement for each dwelling unit. (PURC, 25.141).

In New York State, tenant rent is adjusted to include a utility allowance. This is supposed to reflect the amount deemed sufficient to cover the basic utility costs for an energy-conservative household. The allowances are as follows:

Table 2.1: Utility Allowances (effective October 1, 2008)

Number of Bedrooms	Gas Only	Electric Only	Total w/Gas & Electric
SRO	21	49	70
Studio	54	49	70
1	24	54	78
2	26	60	86
3	26	70	96
4	27	77	104
5	27	90	117

Source: Utility allowance in New York State, 2009.

2.4.0 Disadvantages of compound house metering.

Often the lighting points and sockets are counted as the bases of determining the number of points that a family consumes, and the bill is shared in the ratio of the points of all the families. This is the case despite the fact that appliances on these points do not have the same ratings. The number of points that a family has is not related to the units of electricity it consumes. A family could have points that consume less electricity than those of other families. For instance a 100W bulb may be used by one tenant where as another may use a 40W bulb per point. Some families will have appliances that other families cannot afford. And the frequency of use of electricity varies widely among families.

Efforts at electricity conservation in such situations are impracticable. Every tenant thinks that he/ she has no way of reducing overall consumption since he/ she cannot control electricity usage of the other tenants. Each of them ends up resolving to use as much as is needed or be cheated by co-tenants. There is no need in this case to sacrifice your comfort in the name of reducing electricity bills.

The PURC established tariff structure for residential customers in Ghana is a 4- tier tariff. The first tier of up to 50kwh per month is for lifeline consumers. Succeeding tiers have higher tariff rates. Due to the accumulation of energy consumed from the families in compound houses, total energy consumed in the month moves into the higher tariff bracket, making families worse off.

Tenants in compound houses often are at each other's throats as a result of the mode of apportioning of utility bills. You often find tenants who are not in a position to pay or seem to care less about the bill. This inconveniences co- tenants, since such an attitude usually results in disconnection of service. The landlords who preside over the apportioning of the bills further often cheat them.

It is surprising to know that this situation also exists even in the developed world. According to (Yomiuri, 2009, September 4) tenants of a commercial building in Minami, an entertainment district in southern Osaka, Japan have protested a landlord's practice of padding electricity expenses even after legal rulings had been finalized against the landlord in favour of the tenants. (Yomiuri, 2009, September 4) reported that five tenants of the building filed suits against the landlord between 2003 and 2005 with the Osaka District Court, demanding reimbursement. Although the plaintiffs won the suits, receiving a total of 5 million yen as repayment for the padded charges, they claim that the landlord has continued to overcharge them. (Yomiuri, 2009, September 4).

It was reported by the (Energy Star, 2002), in the USA that Government agencies, K-12 schools, and privately owned facilities generally receive utility bills showing individual building energy use and costs as gathered from utility meters. However, colleges and universities with multiple buildings on campus generally do not receive utility bills for each building and have traditionally not found it cost effective to sub-meter the campus to collect such data. The volatility of energy supplies and costs, as well as the restructuring of the electricity industry has affected this

traditional view; as a result, many schools find themselves evaluating the costs/benefits of separate metering.

2.5.0 Tariff policy and its impact on compound houses.

Ghana's residential tariff structure has moved from 5 sub-groups based on levels of consumption, to four and then three during the 2003 tariff review process. (ESMAP, 2005, December). The report explained that the lowest group, the lifeline, offers a flat rate to customers consuming 50 KWh per month or less, and was originally created to minimize the cost to the utility of billing small accounts. It further indicated that starting in August of 2002, the Government of Ghana (GOG) introduced a subsidy for those consuming within the lifeline, and it came to be used as a tool for ensuring that lower income users were protected from tariff increases. When the automatic adjustment formula for tariffs was set to start in 2002, the GOG increased the subsidy on the lifeline to protect this block from the automatic adjustment. A specificity of housing in Ghana is the existence of shared compound houses; policy makers were concerned that these houses were not able to benefit from lifeline tariffs, and that they were among the most vulnerable. (ESMAP, 2005, December).

The fixed user service cost represents the cost of billing, processing, etc and shall be recovered from monthly service charges imposed on all consumers who are not on pre-paid metering. (PURC, 1999, December).

Residential customers shall pay electricity tariff on the basis of energy (kWh) and shall be grouped into three classes on the basis of the level of consumption determined by the PURC in consultation with the Distribution Utility from time to time. (PURC, 1999, December).

(PURC, 1999, December) stated 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. According to (PURC, 1999, December) the affordability concern shall be addressed through the institution of a lifeline supply level and tariff that shall ensure that a certain quantity of electricity is provided at a low rate, such that low-income customers can afford to meet basic needs. The rate for the lifeline consumption shall be related to the following factors as appropriate:

(i) National Monthly Minimum Wage;

(ii) Ability to pay of Rural Consumers;

(iii) The price of a gallon of kerosene;

(iv) Average cost of hydro; (PURC, 1999, December)

(PURC, 1999, December) continued that Non-Residential customers shall pay electricity tariff on the basis of energy (kWh) and shall be grouped into two classes on the basis of the level of consumption to be determined by the PURC in consultation with the Distribution Utility from time to time. Table 2.2 below shows the PURC tariff structure as discussed.

Table 2.2: Tariff Approved by PURC in 2003

Tariff Category **Residential** (kWh).	**Effective August 1, 2002 (¢)**	**Effective March 1, 2003 (¢)**
0-50 (Exclusive "Lifeline" Block Charge)	14000	18000
51- 300	400	550
300+	960	960

N o n - R e s i d e n t i a l 0-300 300+ Service Charge (Cedis/month	 750 980 20000	 800 980 20000

Source: PURC Electricity Tariff for 2003

The life- line philosophy and cost subsidizing are not only practiced in Ghana. The table below shows the average cost of supply and the final price (after direct subsidy) for different users in Honduras:

Table 2.3: Subsidizing Electricity Cost In Honduras

	Average Cost of Supply (kW·h)	**Current price (after subsidy) ($/kW·h)**	**No. of Users**
Residential Block (kW·h/month)			
0-50	0.224	0.039	174,338
51-100	0.158	0.04	132,804
101-150	0.147	0.047	128,361
151-300	0.141	0.066	242,723
301-500	0.137	0.089	83,368
501-	0.134	0.109	43,747
Industrial	0.107	0.105	134
Commercial	0.130	0.133	59,700

Source: World Bank data on Electricity cost in Honduras, 2007.

The tariff structure in the state of Aurora is also as follows;

Residential light and power

Fixed charges ..... 63.847c per day

First 500 kWh per quarter .....18.511c per kWh

Next 1000 kWh per quarter .....17.616c per kWh

Remainder .....15.016c per kWh

(Aurora Energy, 2008).

In Malta, electricity tariff is based on five blocks with higher tariff as the blocks increase;

Table 2.4 Residential Rates (inclusive of 5% VAT)

Band	Cumulative Consumption	1 Jan 2010 Tariff
1	0 - 2,000	0.161
2	2,001 - 6,000	0.173
3	6,001 - 10,000	0.189
4	10,001 - 20,000	0.360
5	20,001 & over	0.620

Source: Malta Electricity tariff, (Enemalta, 2010).

2.6.0 Negative practices of tenants to avert high electricity bills.

Tenants in some compound houses connive to cheat utilities at moments when they know that they are not likely to be checked. Whilst some tenants cannot agree to cheat, unscrupulous tenants bypass their energy meters at night. One brand of prepayment meter manufactured by Holley is noted for

being vulnerable to “U-touch” bypassing in the NED operational area. A wire is cut into a U shape to facilitate bypassing from about 7:00pm to 6:00am.

The gears of electromechanical energy meters are often also cut, blocked or jammed to slow it down during metering. The pivots of the dial of the electromechanical energy meter are sometimes loosened to impede the rotation of the dial and result in lower readings.

Meter terminals are loosened in the hope that lesser current gets registered or line and load wires are connected in the same meter terminal to bypass the meter.

The general view is that tenants hide from their fellow tenants and use some of their appliances especially those that consume relatively higher units of electricity e.g. irons, hand water heaters, hair dryers etc. while maintaining that they don’t have such appliances.

2.7.0 Wiring requirements for separating tenants.

In Ghana tenants are expected to engage electricians to separate the wiring of the tenant’s rooms from the rest of the rooms and terminate the various circuits to a distribution board placed at a convenient location of the house for metering. Such a separate meter is connected from the parent meter cut out fuse.

2.8.0 Inability of NED to meet demand for separate meters.

There is common dissatisfaction among tenants because of the shared meter. NED has placed conditions for provision of any extra meter in compound houses. This is because NED cannot meet the demand for meters by all tenants.

According to the (VRANED, 1987) separate meters may be allowed if the consumption on the parent meter of a residential account is high i.e. two to three times the average residential consumption and the account is known to serve more than one household unit.

Flat-rate accounts are those whose consumption are estimated and billed. This of course is not satisfactory to both utility and the affected customers since such rates are not accurate. This goes without saying that NED will only provide all tenants in compound houses with meters when it stands to benefit and the initial capital is available.

2.9.0 Challenges in separate Metering.

From the point of view of the (Energy Star, 2002), in the USA the main disadvantage to the college of smaller metering units is that, if peak demand is billed separately, the combined peak demand charges of the smaller meters will be greater than the peak demand charge of a single large meter. Additional disadvantages include individual customer service charges for each meter and higher rate structures for smaller loads.

According to (Todorow et al, 2005) of Canada the proponents of separate metering argue that separate metering is more equitable for tenants as each tenant household only pays for actual use. However, the reality is that electricity consumption, is driven in part by factors outside of the control of tenants. (Todorow et al, 2005) further states that regardless of household use, different units use different amounts of energy. A tenant in a corner unit will require more energy to heat the unit than a tenant in the middle of the building. A north-facing unit will be more expensive to heat than a south-

facing one. (Todorow et al, 2005) concludes that with separate metering, tenants in units with higher energy costs will be penalized.

The risk of fire is heightened by the installation of several separate meters. This arises out of the requirement for separation of wiring circuits of the beneficiary from the rest of the rooms. With time there would have been many rewiring done in a particular building, which is a recipe for wrong wiring or loose contacts.

The present arrangement in NED is for individual tenants to apply for the separate meter with the permission of the landlord. That means every tenant is illegible for a separate meter. This makes the demand for separate meters very high. However if the system was such that when a building qualified for consideration for a separate meter, only the landlord could be provided with additional meters to his building, then the tenants would have shared the meters equally. In this case with the installation of two or three meters in a compound house, tenants would have been satisfied with the electricity bills they have to pay. In the present situation as many as four or five separate meters could be found in a house while tenants still crave for extra separate meters.

2.10.0 Benefits of Separate Metering.

From a business perspective, the benefits of separate metering include:

- Separates energy use in facilities that receive funds from different sources, e.g., state-supported versus auxiliary, instruction versus research, academic versus hospital.

- Facilitates charge-backs to departments or other campus units as a way to encourage energy efficiency measures.
- Assists in developing cost recovery and overhead analyses as they apply to sponsored research. At some institutions, details on energy usage are used to determine overhead rates so that research done in one facility does not effectively subsidize work done in another.
- Verifies savings from energy improvement projects. (Energy Star, 2002)

From an engineering perspective, the benefits of separate metering include:

- Identifies performance improvements and guides preventive maintenance: trends in monthly and annual use of each form of energy help to identify the benefits received from system upgrades and also the energy systems (e.g., boilers or chillers) that may need attention if they show unexpected increases in use.
- Enables quick response to failures of system components, assuming the meters are linked to an energy management system (EMS).
- Helps to compile baseline energy use for setting contractual terms with an energy service company (ESCO). (Energy Star, 2002)

From a management perspective, the benefits of separate metering include:

- Assists in making decisions about energy upgrades in buildings by comparing energy use in similar facilities.

- Focuses accountability for building operations on the facilities department, encouraging building managers to control energy consumption.

The separate metering of individual buildings helps to evaluate performance and to identify problems. it makes it easier to identify energy saving measures and to quantify benefits, and can be implemented at various scales and levels of process integration. (Consortium, 2007, January).

2.11.0 PURC requirements for metering customers.

The PURC currently has no regulations on providing meters to tenants of compound houses. However with the trend in regulating utilities one can predict that sooner or later it will address itself to the issue. There are however regulations in how and when to disconnect customers, response time to customer complaints, mode of disconnection etc.

2.12.0 Landlord/ Tenant relations

In Ghana many are the cases where landlords or tenants refuse to pay bills, because of disagreement on how bills are shared. These create tensions in compound houses and sometimes lead to evictions and vacation of tenancy.

Sometimes a landlord decides whether the tenant gets electricity or not. The following case from India is an example. (Utkarsh, 2010, June 11) reports that Justice Gambhir also found no favour with the views that the Delhi Electricity Supply Code Performance Regulations restricted installing a separate meter unless there was a no-objection-consent in writing from a landlord. The court observed that electricity being an indispensable

commodity had to be provided to a consumer if he was willing to pay and abide by all the other regulations.

(Utkarsh, 2010, June 11) continues that the court held so while adjudicating a writ petition filed by Dayal Krishna Phadiyal, who was compelled to approach the court after his landlady Sumandri Devi got the electricity connection of his shop at Laxmi Nagar disconnected following a dispute in February 2009. When Phadiyal asked her to give a no-objection-consent so that he could get a separate meter installed, she flatly refused.

According to (Utkarsh, 2010, June 11) armed with all the requisite documents, Phadiyal approached BSES Yamuna officials, but to no avail. They said they could not help him until and unless he had a no-objection-consent from his landlady.

In other cases tenants have absconded with electricity bills and left landlords with huge bills to settle with utility companies. (Foong, 2010, June 13) reports that in Malaysia residential landlords were left to foot large amounts of power bills, amounting to tens of thousands of ringgit in some cases, which were not settled by tenants who moved out. According to (Utkarsh, 2010, June 13) the landlords were helpless as they were held responsible by Tenaga Nasional Bhd (TNB), and could not re-connect supply for new tenants or sell their homes without paying the bills. Many blame TNB for their predicament, saying the bills would not have surged to such high figures if the utility company had been strict and cut off supply to errant consumers at the early stages. According to (Foong, 2010, June 13) several online forums confirmed that the problem was widespread, with many

residential property owners expressing frustration with their tenants' unpaid electricity bills.

(Aminu, 2009), cited the case of Adollo versus Adeyemi { (1966) 2 ALL NLR 96 } Nigeria, where the landlord without going into the tenant's room cut off the supply of electricity to the tenant's room. The tenant thereupon brought an action against the landlord in tort claiming damages for the landlord's malicious action in disconnecting the supply of electricity to his room. After the hearing at the Magistrate's Court, the trial Magistrate gave judgment for the tenant by holding that the tenant had a right to be supplied electricity and that the landlord's invasion of this right amounted to a tort for which he was liable.

(Aminu, 2009), stated that, the landlord appealed against the judgment. On appeal, the counsel for the landlord argued that the landlord is the owner of the premises and that he installed the meters in the house and interference by him with the meters in the house cannot give rise to an action of tort against him at the instance of the tenant. On the other hand, the counsel to the tenant argued that the tenant has a right to the supply of electricity to his room and any unlawful interference with that right by the landlord was tortuous act for which the landlord would be liable in damages.

While it is mostly landlord versus tenant in rent disputes, tenant to tenant disputes also arises as in this online chat from Jamaica. Hello everyone, I am a new poster on askmehelpdesk.com and I am in a difficult situation with one of my old roommates. I want to get all of the information out of the way early. I live in Boston, MA in a three bedroom apartment. Our energy company is NSTAR. I live with one roommate who was originally on

the lease and one other roommate left a few months ago and now another kid is on our lease. Anyway the story is, we are now in the stages of paying our old electric bill from when we moved in until a few months ago (about 12 months) when the old roommate left. We were confused about who was paying the bill, the landlord or us (the tenants) and the electric company just contacted us to let us know we needed to pay. So we all originally co-signed on the lease and now the old roommate is refusing to pay his fair share of the electricity bill because he believes that we didn't do enough to contribute to saving energy and he feels like he is entitled to pay less because he thinks he used less energy. I'm starting to get very frustrated and my question is this. If he refused to pay his fair share (33%) of the total bill and we end up taking him to small claims court, are we pretty much guaranteed to get the money on the grounds that he was a co-signer and he has the responsibility to pay the bill just like both of us? Also I want to prepare ahead of time so I was wondering if anyone could help me out with some links to sites with helpful information and maybe the forms I would need to file this suit in small claims court if it comes to it. Your help would be greatly appreciated because I have been trying to work this out for some time and I feel like I'm running around in circles with one short leg. (Mike, 2007, May 13).

Electricity bill-settlement disputes between landlords and tenants cuts across all countries. Despite arrangements in every tenancy, the court most often decides on the cases. The situation is not different in Zimbabwe from the following narration. (The Herald, 2009, May 19) reports that the rent dispute between Old Mutual Properties and their tenants spilled into the courts with an insurance broker seeking an injunction preventing the insurer

from cutting electricity for those in arrears. The court gave the temporary relief sought, without looking into the merits of the application, until the hearing at the Harare Magistrates' Civil Court. According to the (Herald, 2009, May 19) Progressive Insurance Brokers (Pvt) Ltd are one of several tenants who have been embroiled in the dispute with Old Mutual Properties over unpaid rent. The dispute led to Old Mutual switching off electricity to tenants in arrears at their properties at CABS Centre and the Eastgate office complex. Progressive Insurance Brokers subsequently approached the courts seeking an order to bar Old Mutual from switching off electricity over rent arrears. According to the (Herald, 2009, May 19) in its founding affidavit, filed through the company's group legal and human resources manager Mr Floyd Kurima, progressive Insurance Brokers said it had been leasing the premises at CABS Centre for the past eight years. He said on April 17 this year, Old Mutual Properties sent a letter proposing an increase in rent. The (Herald, 2009, May 19) stated that there was disagreement over the figure that Old Mutual proposed but the latter went ahead and switched off electricity supplies even though negotiations were still ongoing. The two parties were scheduled to meet to discuss the impasse on May 7, but power had already been disconnected by then. Progressive Insurance Brokers submitted that the action was illegal and unlawful, as Old Mutual took the law into their own hands and switched off electricity without a court order.

2.13.0 Illegal trade in meters.

The shortage of meters has created a customer need that is not satisfied. With the passage of time electrical contractors found this to be an avenue to steal meters from projects for sale to customers in need.

The government of Ghana embarked on electrification projects for the past fifteen years in rural areas under the Self- Help Electrification Project (SHEP). The contractors awarded contracts for this project trained men on the job. Some of these men get away with project items including meters and sell them to customers.

Some customers have cited unverified cases where meters were sold to them by men who claim to be staff of NED.

2.14.0 The future of metering in NED.

With advances in technology, different kinds of meters have been developed with features that suit particular applications. Some of the technologies are discussed below.

An advanced meter is an electronic meter that can at least be read remotely. In the future, advanced meters will provide many capabilities beyond this basic requirement, and afford a number of potential advantages to energy service providers (ESPs) and their customers. Some of the features of advanced metering are;

1) Customer control: Customers gain access to information on their current energy usage and real-time electricity prices.

2) Demand response: Power utilities can more effectively send control signals to advanced metering systems to curtail customer loads, either directly or in cooperation with the customer's building automation system.

3) Improved reliability: More agile demand response and Distributed Energy Resource (DER) management can improve the reliability of the distribution grid by preventing line congestion and generation overloads.

4) Simplified separate metering: Multiple customers can be monitored by a single meter, reducing equipment costs and maintenance burdens. In some settings, it may even be possible for an MDMA to collect readings from multiple meters in a hierarchical fashion. There are several distinct categories of advanced metering systems that support the functionality discussed above with varying degrees of success. The least capable systems use short-range radio networks, requiring readers to drive by in vans to read the meters. More capable systems support unidirectional fixed network communication, and the most capable systems have fully bidirectional network connections. The less capable systems are typically less expensive to deploy initially, but fully networked systems provide more economic benefits in the long run. (LeMay et al, 2007).

2.15.0 Comparison of cost of alternative sources to electricity

In the absence of electricity, households use kerosene and candles as substitutes for mainly lighting and probably for refrigeration. The other uses of electricity i.e. for TV and radio can be fulfilled with dry cell batteries. Air-condition, fan and iron presently have no alternative source of supply.

Therefore some gadgets cannot be used without electricity. Improvement in life styles with use of electricity is obvious. If computed the total cost of using the alternative sources of energy does not compare favourably with that of electricity. As such despite the inconvenience of sharing electricity bills, customers do not resort to the alternatives.

2.16.0 Energy Conservation in compound houses.

While in Ghana metering individual families in a compound house might enhance energy conservation, in Canada it is thought that providing

separate meters to tenants will worsen the plight of the tenants and swap energy conservation responsibilities between the landlord and the tenants. The Ontario government's plan to allow landlords, without the consent of the tenants, to install electrical separate meters in existing multi-residential buildings is a flawed conservation strategy and would amount to a government-mandated breach of contract with respect to the landlord-tenant relationship (Todorow et al, 2005). According to (Todorow et al, 2005) electrical separate metering in apartment buildings is not cost-effective, not an effective method of energy conservation, and not fair to tenants.

The reason for the paradox between Ghana and Canada is as follows. (Todorow et al, 2005) notes that separate metering shifts the incentive to conserve from the landlord to the tenant. This shift shields the landlord from the responsibility to provide an energy efficient building and appliances for the use of tenants, and represents a lost conservation opportunity. Conservation strategies within the control of the landlord are primarily structural strategies, while those within tenant control are behavioural (Todorow et al, 2005). While both are important, structural changes result in almost guaranteed and persistent energy conservation, while behavioural strategies do not. However in Ghana the landlord is under no obligation to put up structures that will ensure energy conservation.

According to (Todorow et al, 2005) research indicates that separate metering in the residential rental market is not cost effective. In most cases, the cost of installing and operating the sub-meter outweighs the potential electrical savings that can be generated. In 17 of 18 scenarios analyzed, tenants would spend more money annually on the meters than they could

save. Ironically, installation of sub-meters resulted in the highest economic losses with low-use consumers. (Todorow et al, 2005).

2.17.0 Monopoly of electricity distribution.

In Ghana the generation, transmission and distribution of electricity are monopolized by VRA, GRIDCo, ECG, and NED. VRA has a monopoly in generation, GRIDCo has a monopoly in transmission and both ECG and NED have monopoly in distribution in their areas of operations. In this sense the performance of NED cannot be compared with another utility in the operational area so that short falls or advancement could be evaluated.

Customers have no choice. Whether they are dissatisfied with frequency of outages or have too many billing problems or that the conditions of the service are not favourable to customers, they still have to obtain their electricity from NED. In the case of other service providers like MTN, Vodafone, Airtel and Tigo people are able to switch without prior information at the least inconvenience. This is why people take the law into their own hands and tamper with the distribution networks and the meters or acquire meters illegally.

2.18.0 Irregular calibration and maintenance of meters.

Many of the meters in use in NED are the electromechanical meters that are subject to tear and wear. As such they are supposed to be re-calibrated to remain within the tolerance standards in at least every five years. However NED is not able to do this and they are not maintained until they are reported faulty. The accuracy of the meters is therefore in doubt but in a developing country such as Ghana, they still serve the purpose without any conflict.

2.19.0 Cost of separate meter installation.

In the USA several metering companies provide separate metering services by owning, operating, and maintaining the meters. In some cases, these companies provide a long-term contract and incorporate the high capital cost of the sub-meters into a flat monthly fee, which includes software assistance and periodic calibration and maintenance. Monthly fees are based on the type of service needed and the quantity of sub-meters served. Monthly costs per sub-meter range from $150 to $400. (Energy Star, 2002).

As noted by (Todorow et al, 2005) in most cases, the cost of installing and operating the sub-meter outweighs the potential electrical savings that can be generated. This research finding might be overturned in reference to Ghana where tenants prefer to install their separate meter to reduce spending on electricity. There is no consideration of the cost of the meter and operation since that is the responsibility of the utility.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1.0 Definition of Research

According to (Dawson, 2002) when you say that you are undertaking a research study to find answers to a question, you are implying that the process;

- Is being undertaken within a framework of a set of philosophies.
- Uses procedures, methods and techniques that have been tested for their validity and reliability;
- Is designed to be unbiased and objective.

She explains that philosophies mean approaches for example, qualitative, quantitative and the academic discipline in which you have been trained. Validity means that correct procedures have been applied to find answers to a question. Reliability refers to the quality of a measurement procedure that provides repeatability and accuracy. Unbiased and objective, means that you have taken each step in an unbiased manner and drawn each conclusion to the best of your ability and without introducing your own vested interest.

Adherence to the three criteria mentioned above enables the process to be called research. However, the degree to which these criteria are expected to be fulfilled varies from discipline to discipline and so the meaning of research differs from one academic discipline to another.

According to (Dawson, 2002) the word research is composed of two syllables, re and search. Re- is a prefix meaning again, anew or over again, search is a verb meaning to examine closely and carefully, to test and try, or

to probe. Together they form a noun describing a careful, systematic, patient study and investigation in some field of knowledge, undertaken to establish facts or principles. (Dawson, 2002) said research is a structured enquiry that utilizes acceptable scientific methodology to solve problems and create new knowledge that is generally applicable. Scientific methods consist of systematic observation, classification and interpretation of data. (Dawson, 2002)

3.2.0 Definition Of Research Methods

According to Webster dictionary, methodology can be the analysis of the principles of methods, rules, and postulates employed by a discipline or the systematic study of methods that are, can be, or have been applied within a discipline. The path to finding answers to your research questions constitutes research methodology. (Dawson, 2002). Methodology may entail a description of generic process or metaphorically, may be extended to explications of philosophically coherent concepts or theories as they relate to a particular discipline or field of inquiry. By similar reasoning (Dawson, 2002) said methodology refers to the rationale and/or the philosophical assumptions that underlie a particular study or a particular methodology

3.3.0 Research Strategy

(Jeffrey et al, 2005) quote that quantitative researcher (Kerlinger, 1978) as saying, there's no such thing as qualitative data. Everything is either 1 or 0. To this another researcher, (Campbell, 1959) asserts all research ultimately has a qualitative grounding. This back and forth banter among qualitative and quantitative researchers is essentially unproductive according to (Miles et al, 1994). They and many other researchers agree that these two

research methods need each other more often than not. (Jeffrey et al, 2005) continue that however, because typically qualitative data involves words and quantitative data involves numbers, there are some researchers who feel that one is better (or more scientific) than the other. Another major difference between the two is that qualitative research is inductive and quantitative research is deductive. In qualitative research, a hypothesis is not needed to begin research. However, all quantitative research requires a hypothesis before research can begin.

(Jeffrey et al, 2005) note that another major difference between qualitative and quantitative research is the underlying assumptions about the role of the researcher. In quantitative research, the researcher is ideally an objective observer that neither participates in nor influences what is being studied. In qualitative research, however, it is thought that the researcher can learn the most about a situation by participating and/or being immersed in it. These basic underlying assumptions of both methodologies guide and sequence the types of data collection methods employed.

Although there are clear differences between qualitative and quantitative approaches, some researchers maintain that the choice between using qualitative or quantitative approaches actually has less to do with methodologies than it does with positioning oneself within a particular discipline or research tradition. The difficulty of choosing a method is compounded by the fact that research is often affiliated with universities and other institutions. The findings of research projects often guide important decisions about specific practices and policies. The choice of which approach to use may reflect the interests of those conducting or benefitting from the

research and the purposes for which the findings will be applied. Decisions about which kind of research method to use may also be based on the researcher's own experience and preference, the population being researched, the proposed audience for findings, time, money, and other resources available. (Hathaway, 1995).

According to (Jeffrey et al, 2005) some researchers believe that qualitative and quantitative methodologies cannot be combined because the assumptions underlying each tradition are so vastly different. Other researchers think they can be used in combination only by alternating between methods: qualitative research is appropriate to answer certain kinds of questions in certain conditions and quantitative is right for others. And some researchers think that both qualitative and quantitative methods can be used simultaneously to answer a research question. If one is to study historical consumption data, as this study did, then a quantitative method has to be employed.

To a certain extent (Jeffrey et al, 2005) thinks that, researchers on all sides of the debate are correct: each approach has its drawbacks. Quantitative research often forces responses or people into categories that might not fit in order to make meaning. Qualitative research, on the other hand, sometimes focuses too closely on individual results and fails to make connections to larger situations or possible causes of the results. Rather than discounting either approach for its drawbacks, though, researchers should find the most effective ways to incorporate elements of both to ensure that their studies are as accurate and thorough as possible.

It is a desirable idea to conduct a survey of tenants of compound houses to seek their views on separate metering therefore both quantitative and qualitative methods were combined in this study.

3.4.0 Research Design:

According to (Kothari et al, 1985, 2002, 2005), research design is the conceptual structure within which research would be conducted. The function of research design is to provide for the collection of relevant information with minimal expenditure of effort, time and money.

The preparation of research design, appropriate for a particular research problem, as noted by (Kothari et al, 1985, 2002, 2005) involves considering the objectives of the research study, method of data collection, source of information, tool for data collection and, data analysis.

There are two types of data; Primary Data- collected for the first time and Secondary Data- those which have already been collected and analyzed by someone else. (Kothari et al, 1985, 2002, 2005). This study collected primary data from NED CBMS.

Data could be collected by investigator's own direct observation of relevant people, actions and situations without asking from the respondent. In a structured survey a formal list of questions are asked of all respondents. Unstructured Surveys let the interviewer probe respondents and guide the interview according to their answers. The information may be collected by mail, telephone or personal interview.

(Kothari et al 1985, 2002, 2005) an experimental method is a data-based research, coming up with conclusions which are capable of being verified with observation or experiment. Such research is characterized by

the experimenter's control over the variables under study and the deliberate manipulation of one of them to study its effects. (Kothari et al, 1985, 2002, 2005) mention that the researcher must provide self with a working hypothesis or guess as to the probable results. He should work to get enough facts (data) to prove or disprove the hypothesis. He then sets up experimental designs which he thinks will manipulate the persons or the materials concerned so as to bring forth the desired information. (Kothari et al, 1985, 2002, 2005). Evidence gathered through experimental or empirical studies today is considered to be the most powerful support possible for a given hypothesis.

For this study, a number of compound houses were selected from Tamale, Salaga, Damongo, Savelugu, Gushegu, Bimbilla and Kete Krachi, all Stations under Northern Area. Appendix D. The sample taken depended on the availability of data on each sample. Those accounts from which the consumption before and after separate meter installations were available, were those that were selected. Separate meter accounts installed for each of these houses were taken including the parent (original) meter account. The date of connection of the meters was noted so that a starting point (month) of the study could be chosen that was common to the accounts in each house.

Three months consumptions from the common starting month for each account were taken and an average consumption for each computed. (Table 4.1). The consumption of each account over an extended period of 12 months was taken from April 2010 to March 2011. For each month from April 2010 to March 2011, the separate meter consumption in each compound house is summed up and subtracted from the average

consumption of the parent meter at the beginning. The consumption of the parent meter after the meters were separated was also added to the sum. If consumption was increased after the separation, then a negative figure should result. (Table 4.2). The negatives were used since that represented an increase which was being investigated.

For each station, the number of negative figures was counted. Percentages of the negatives were calculated. (Table 4.3). The same procedure was followed for data of accounts for houses with one meter occupied by one family. This was to act as a control data for the study. (Table 4.4). The data on the percentages of negatives was treated on a completely randomized block design model and an F value computed to analyse the effect of time elapsed on consumption and that of location (station) on consumption. (Table 4.7).

The consumption at the time of installation of the meters was used on the March 2011 PURC tariff to obtain the bills. The cost per unit of electricity was computed. The average consumption of the parent meter account, before other meters were added, was divided by the number of separate meters presently installed. The March 2011 PURC tariff was applied on the result and compared with the present tariff structure of using the consumption of the whole house (parent meter consumption) to bill.

The costs and benefits of installation of meters for individual tenants were converted into monetary terms.

3.5.0 Population:

According to Wikipedia (accessed June 7, 2011) a population can be defined as including all people or items with the characteristic one wish to

understand. The population in this study was the accounts of all compound houses provided with separate meters in the Northern Area of NED.

3.6.0 Sampling:

(Khan, 2005) defines the process of inferring something about a large group of elements by studying part of it is termed as sampling. (Khan, 2005) stated the reasons for sampling: - sampling is preferred to studying of a whole population. The quality of data collected is higher from a sample than from a large population. There is enough information gathered from a sample for which no further reliability can be achieved from enumeration of the population in spite of substantial amount of money that would be spent on studying a population. Due to practical difficulties it is sometimes infeasible to enumerate a complete population. It could be physically impossible to study the population because the item under study must be destroyed to study it. The time spent on sampling is far reduced than for complete enumeration.

A selection of eighty seven (87) accounts was randomly sampled from seven district capitals i.e. Tamale, Damongo, Savelugu, Salaga, Bimbilla, Gushiegu and Kete Krachi. The emphasis was placed on residential accounts. It was assumed that the number of households in each compound house remained constant. Another sample of twenty one (21) households with dedicated energy meters (one meter one house) was also taken from these seven stations as a control or reference sample.

3.7.0 Research Instrument

(Mosby, 2009) defines research instrument as a testing device for measuring a given phenomenon, such as a paper and pencil test, a

questionnaire, an interview, a research tool, or a set of guidelines for observation.

The main research instrument relied upon was the customer billing management system (CBMS) of NED where the primary database was obtained. The primary data was analysed using Analysis of Variance (ANOVA) in a randomized complete block design model. A questionnaire was also administered to residents of compound houses. The unit cost of electricity was studied using two different tariff structures. Cost benefit of installing individual meters for all tenants of compound houses in the Northern Area was evaluated.

3.8.0 Administration of Research Instrument

The CBMS database provides historical consumption on each account. Whilst logged onto the CBMS database, the monthly consumption are extracted into an MS Excel sheet for each station (district capital). Some accounts unfortunately may not have data over all the periods specified. Some history of the accounts may also be estimated consumptions such as when a meter is damaged or the premises become inaccessible.

3.9.0 Data Analysis/Presentation Procedure:

ANOVA method was used to study the data by presenting it in a randomised complete block design.

To randomly sample is to enable a research to be done in a way to reduce the influence of uncontrolled variables in the samples on the effect of the study. In a randomized design the population means are tested to identify any tendency of the means of the individual elements to vary.

This lead to the formation of a null hypothesis which was tested to determine the truth or otherwise of the nature of the means of the variables.

The samples were independent of each other it was assumed that the population under study was normally distributed with equal and independent variances.

A block design method was used in order to eliminate the effects that were known to be important but which were not the ones under consideration (Sidney, 1969). It is a procedure that allows the conducting of one overall test to see if there are any group differences among the groups while maintaining the level of significance of the test; that is 5%. (Sidney, 1969). ANOVA is based on the F- statistical test. An F-test is any statistical test in which the test statistic has an F-distribution under the null hypothesis. Wikipedia (Accessed 2011, June 7). The F- statistic was calculated from the ANOVA table and compared with the value in the F- table corresponding to the degrees of freedoms in the study. According to Wikipedia (Accessed 2011, June 7) the null hypothesis is rejected if the calculated figure is more than that from the F- table. The disadvantage of the ANOVA F-test is that if we reject the null hypothesis, we do not know which treatments can be said to be significantly different from the others. Wikipedia (Accessed 2011, June 7).

The cost activity items and the benefits for the installation of the individual meters were identified and valued. The cost and benefits were evaluated for the tenant and for the utility- NED.

CHAPTER FOUR

RESULTS, ANALYSIS AND DISCUSSION

4.1.0 ANALYSIS:

4.1.1 Analysis of Variance:

Table 4.1 below shows the averages at the inception of billing of the accounts involved by using three months average. The account numbers in bold are parent meter accounts.

Table 4.1: Extract of Primary Data

TAMALE									**FEBRUARY 2010 TO MARCH 2011**											
ACCOUNT NUMBER	**HOUSE NUMBER**	**DATE**	**FIRST 3 MONTHS**	**1st MONTH**	**2nd MONTH**	**3rd MONTH**	**AVERAGE SEPARATE**	**AVERAGE PARENT**	**APR '10**	**MAY '10**	**JUNE '10**	**JULY '10**	**AUG '10**	**SEPT '10**	**OCT '10**	**NOV '10**	**DEC'10**	**JAN '11**	**FEB '11**	**MAR '11**
201-34978	**GK 157**	AUG 2007	AUG, SEP, OCT 07	165	184	231		193.33	403	329	361	301	353	319	324	338	516	292	427	523
			AUG, SEP, OCT 10	353	319	324	332.00													
201-34979	GK 157	AUG 2007	AUG, SEP, OCT 07	107	110	95	104.00		133	113	114	83	95	92	90	68	136	107	138	161
			AUG, SEP, OCT 10	95	92	90	92.33													
201-46896-0	GK 157	JAN 2010	AUG, SEP, OCT 10	103	111	97	103.67		108	97	94	81	103	111	97	108	145	102	141	160
SALAGA																				
205-02040-0	E761	26/06/ 2008	JUL, AUG, SEP08	90	0	50		46.67	301	149	190	141	189	119	154	131	136	97	114	108
			JUL, AUG, SEP 10	141	189	119	149.67													
205-04143-0	E761	23/12/ 2009	JUL, AUG, SEP 10	40	69	31	46.67		59	54	106	40	69	31	46	12	42	43	47	18
DAMONGO																				
206-00392-0	C100 B	17/03/ 2005	APR, MAY, JUN 05	96	120	120		112	182	107	104	171	99	87	65	83	82	49	128	78
			APR, MAY, JUN 10	182	107	104	131													

206-01681-0	C100		APR, MAY, JUN 10	173	145	119	145.67		173	145	119	191	133	75	42	78	40	114	151	138
206-02538-0	C100	31/03/2010	APR, MAY, JUN 10	47	40	32	39.67		47	40	32	79	44	45	35	688	65	54	57	53
SAVELUGU																				
203-006250	B62	31/5/2004	MAY, JUN, JUL 04	267	80	100		149	100	67	66	71	66	33	37	64	90	65	93	97
			MAY, JUN, JUL 10	67	66	71	68													
203-043780	B62	31/1/2010	MAY, JUN, JUL 10	35	36	37	36		0	119	35	36	37	37	35	26	43	35	53	75
BIMBILLA																				
210-008930	A57	31/5/2004	MAY, JUN, JUL 2004	200	206	323		243	174	281	238	128	290	176	223	294	241	134	183	264
			MAY, JUN, JUL 07	88	164	110	120.67													
210-042260	A57	31/01/2007	MAY, JUN, JUL 07	6	11	12	9.67		55	61	60	58	55	1	0	65	67	34	49	62
KETE KRACHI																				
211-008730	A13	4-Dec	OCT, NOV, DEC 04	1	2	50		17.67	183	97	36	45	15	0	0	69	137	176	50	64
			OCT, NOV, DEC 10	15	69	137	73.67													
211-056030	A13	,OCT 2010	OCT, NOV, DEC 10	20	5	68	31				0	0	0	0	20	5	68	5	3	3
GUSHEGU																				
207-000780	NK9	MA 04	OCT, NOV, DEC 04	97	85	107		96.33	140	140	140	140	0	13	51	0	100	127	100	109
			OCT, NOV, DEC 09	100	127	109	112													
207-028800	NK9	,OCT 2009	OCT, NOV, DEC 09	120	103	229	150.67		91	87	0	121	6	2	48	0	30	0	86	259

Source: NED Customer Billing Management System

It will take a lot of space to present the full data of 87 accounts. As such an extract of 16 accounts has been presented herein. See list of all accounts in appendix E.

Table 4.2 investigates individual compound houses to find out if total consumption has increased or reduced.

Table 4.2: Results On Type Of Change In Consumption

TAMALE												
Account No.	**APR '10**	**MAY '10**	**JUNE '10**	**JULY '10**	**AUG '10**	**SEPT '10**	**OCT '10**	**NOV '10**	**DEC' 10**	**JAN '11**	**FEB '11**	**MAR '11**
201-07549-0	-279.11	-319.11	-184.11	-257.1	-188.11	-344.11	-271.1	-238.11	-272.11	-198.1	-324.11	-303.11
201-04331-0	-621.33	-566.33	-365.33	-181.3	-128.33	-195.33	-62.33	-72.33	-57.33	-121.3	-81.33	-118.33
201-28313-0	218.67	236.67	210.67	238.67	229.67	243.67	260.67	236.67	234.67	245.67	288.67	252.67
SALAGA												
205-02040-0	-313.33	-156.33	-249.33	-134.3	-211.33	-103.33	-153.3	-96.33	-131.33	-93.33	-114.33	-79.33
205-02038-0	-285.00	-286.00	-279.00	-134.0	-356.00	-137.00	-73.00	-39.00	-204.00	-182.0	-333.00	-328.00
205-00261-0	-88.00	919.00	-53.00	821.00	225.00	386.00	798.00	249.00	577.00	571.00	771.00	13.00
DAMONGO												
20602119-0	-58.00	-279.00	-50.00	-159.0	-111.00	-67.00	-8.00	-118.00	-120.00	-55.00	-85.00	-42.00
206-02538-0	-290.00	-180.00	-143.00	-329.0	-164.00	-95.00	-30.00	-737.00	-75.00	-105.0	-224.00	-157.00
206-00267-0	-162.00	-86.00	-11.00	-128.0	59.00	78.00	192.00	87.00	-91.00	-54.00	4.00	105.00
SAVELUGU												
203-006250	49.00	-37.00	48.00	42.00	46.00	79.00	77.00	59.00	16.00	49.00	3.00	-23.00
203-016260	-172.67	-155.67	-255.67	-281.6	-260.67	-140.67	36.33	-40.67	-92.67	-114.6	-140.67	-107.67
203-030070	-235.67	-245.67	-275.67	-294.6	-232.67	-170.67	34.33	-375.67	-257.67	-303.6	-200.67	-405.67
BIMBILLA												
210-008930	14.00	-99.00	-55.00	57.00	-102.00	66.00	20.00	-116.00	-65.00	75.00	11.00	-83.00
210-006270	-25.33	-51.33	-1.33	-70.33	-26.33	22.67	11.67	-11.33	-112.33	-23.33	-26.33	2.67
210-042300	78.67	64.67	31.67	72.67	29.67	6.67	71.67	7.67	83.67	21.67	65.67	88.67
KETE KRACHI												
211001760	-11.33	-465.33	-94.33	-77.33	-39.33	2.67	-27.33	-4.33	4.67	39.67	-47.33	-38.33
211030090	-428.33	-310.33	-182.33	-654.3	-703.33	-407.33	-728.3	99.67	-1549.3	-259.3	-1636.3	-1105.3
211008730	-165.33	-79.33	-18.33	-27.33	2.67	17.67	-2.33	-56.33	-187.33	-163.3	-35.33	-49.33
GUSHEGU												
207000780	-134.67	-130.67	-43.67	-164.6	90.33	81.33	-2.67	96.33	-33.67	-30.67	-89.67	-271.67
207001280	36.67	28.67	71.67	5.67	135.67	-60.33	34.67	221.67	230.67	210.67	236.67	26.67
207001280	-40	-28	75	-38	89	-57	6	225	223	214	240	-20

Source: table 4.1

The negative results indicate an increase in consumption. For each station, the number of negative figures was counted. (Table 4.3).

Table 4.3: Number Of Accounts With Increased Consumption After Separation

February 2010 To March 2011

Town	Qty of hse	APR '10	MAY '10	JUN '10	JUL '10	AUG '10	SEPT '10	OCT '10	NOV '10	DEC'10	JAN '11	FEB '11	MAR '11
Tamale	11	8	8	9	7	8	8	8	8	8	8	8	8
Bimbilla	3	1	2	2	1	2	0	0	2	2	1	1	1
Salaga	10	6	7	8	6	7	7	6	6	6	7	7	7
Damongo	19	15	12	9	14	9	14	9	14	10	13	13	6
Savelugu	8	5	6	5	5	5	5	4	5	6	6	7	7
Kete Krachi	3	3	3	3	3	2	1	3	2	2	2	3	3
Gushegu	33	17	25	21	23	12	19	20	17	17	18	15	26

Source: table 4.1

Below is data of accounts for houses with one meter and occupied by one family. This was to act as a control or reference data for the study. (Table 4.4)

Table 4.4: **Non-Compound Houses: Number Of Accounts With Increased Consumption After Separation**

Qty		APR 2010	MAY 2010	JUNE 2010	JULY 2010	AUG 2010	SEPT 2010	OCT 2010	NOV 2010	DEC 2010	JAN 2011	FEB 2011	MAR 2011
NUMBER PER MONTH	21	7	8	7	6	5	7	7	8	7	9	8	10

Source: NED Customer Billing Management System

Table 4.5: The Data In Percentages To Investigate An Increase In Consumption													
Station	**Qty**	**APR '10**	**MAY '10**	**JUNE '10**	**JULY '10**	**AUG '10**	**SEPT '10**	**OCT '10**	**NOV '10**	**DECV '10**	**JAN '11**	**FEB '11**	**MAR '11**
Reference	21	33.33	38.10	33.33	28.57	23.81	33.33	33.33	38.1	33.3	42.8	38.10	47.62
Tamale	11	72.73	72.73	81.82	63.64	72.73	72.73	72.73	72.7	72.7	72.7	72.73	72.73
Bimbilla	3	33.33	66.67	66.67	33.33	66.67	0.00	0.00	66.6	66.6	33.3	33.33	33.33
Salaga	10	60.00	70.00	80.00	60.00	70.00	70.00	60.00	60.0	60.0	70.0	70.00	70.00
Damongo	19	78.95	63.16	47.37	73.68	47.37	73.68	47.37	73.6	52.6	68.4	68.42	31.58
Savelugu	8	62.50	75.00	62.50	62.50	62.50	62.50	50.00	62.5	75.0	75.0	87.50	87.50
Kete Krachi	3	100.0	100.0	100.0	100.0	66.67	33.33	100.0	66.6	66.6	66.6	100.0	100.0
Gushegu	33	51.52	75.76	63.64	69.70	36.36	57.58	60.61	51.5	51.5	54.5	45.45	78.79
Source: table 4.4. Average percentage is 64.54.													

The data obtained was converted into percentages (table 4.5) and then used to test the hypothesis by calculating the F statistic value using the format of Analysis of Variance Table for a completely randomized block design. The model is shown in table 4.6 below. The sample data was as in table 4.5.

Table 4.6: Analysis of Variance Formulae

Sum of Variation	**Sum of Square**	**Degree of freedom**	**Mean Square**	**Computed F value**
Due to treatment	$SSa= b\Sigma(\bar{Y}i.-\bar{Y}..)^2$	a -1	MSa=SSa/(a-1)	MSa/MSn
Due to Blocks	$SSb= a\Sigma(\bar{Y}.j - \bar{Y}..)^2$	b- 1	MSb= SSb/(b-1)	MSb/MSn
Residual	$SSn= \Sigma\Sigma(Yij - \bar{Y}i.+\bar{Y}.j+\bar{Y}..)^2$	(a-1)(b- 1)	MSn= SSn/(a- 1)(b- 2)	
Total		ab- 1		
Source: CEMBA Research Methodology				

i = number of treatments, j= number of blocks,

a= number of months, b= number of stations

$\bar{Y}i.$ = sample means of the treatment effect

$\bar{Y}.j$ = sample means of block effect

$\bar{Y}_{..}$ = mean of sum of both subscripts

The computed F values in the analysis of variance are shown in table 4.7 below.

Table 4.7: **Analysis of Variance for the Sample**

Sum of Variation	Sum of Square	Degrees of freedom	Mean Square	Computed F value
Due to treatment (1-yr)	14163.91	11	1287.63	0.05
Due to blocks	4256.49	7	608.07	0.02
Residual	2141682.51	77	27814.06	
Total		95		

Source: table 4.5 and 4.6

4.1.2 Community Survey

Two sets of questionnaire were prepared to gather some salient data to support the study. One questionnaire focused on the tenants provided with separate meters and the other on the rest still on the parent meter. The questionnaires are attached in appendix A.

4.1.3 Separate effect on Unit Cost of Electricity

The consumption at the time of installation of the meters was used on the March 2011 PURC tariff (appendix B) to obtain bills. The cost per unit of electricity was computed.

4.1.4 PURC Tariff Structure and Compound Houses:

The study investigated the case of a compound house with only one meter installed for all the tenants. The average consumption of the parent meter account, before other meters were added, was divided by the number of meters presently installed. The March 2011 PURC tariff was then applied

on the result and compared with the present tariff structure of using the total consumption of the tenants to bill. See table 4.8.

Table 4.8: To Bill Before Or After Sharing To Tenants				
TAMALE				
Account No.	**individual billing (GH¢)**	**Shared billing (GH¢)**	**Sum of individual (GH¢)**	**Difference (GH¢)**
201-04331-0	3.23	4.26	6.46	-2.20
201-43731-0				
SALAGA				
205-02040-0	2.84	4.67	5.67	-1.00
205-04143-0				
DAMONGO				
20602119-0	6.84	16.37	13.69	2.68
206-02215-0				
SAVELUGU				
203-006250	6.37	15.18	12.74	2.44
203-043780				
Bimbilla				
210-008930	11.93	30.09	23.85	6.23
210-042260				
Source: table 4.1				

4.1.5 Cost- Benefit Analysis

(a) For the tenant:

Cost Items	**Per month (GH¢)**
Cost of re- wiring a room	-0.28
10mm² Copper wire of 20mtr x GH2, *1.5mm² wire, 20mtr x GH1,* *1.0mm² wire, 20mtr x GH1,* *Board GH2, MCB GH10, cut out fuse GH8* *Life span of wiring is taken as 30 years.* *(Depreciation by matching principle)*	
Higher tenant consumption	-6.4
Average increase in consumption from *Study per account is 74.78Kwh i.e. GH¢6.40*	
Total cost for a separate meter installation per month	-6.68

(b) For the utility:

Table 4.9: Cost- Benefit Analysis Of Separate Metering In Northern Area

Cost Items	**Installation of Prepaid meters (GH¢)/ month**	**Installation of credit meters (GH¢)/ month**
Cost of meter reading	Not applicable	-31,500
Cost of installation of separate meters	-170,625.00	-124,687.50
Cost of billing paper	Not applicable	-15,671.25
Cost of inputting data	Not applicable	-5,250
Increase pressure on Cash points	-8,400	-8,400
Increased billing/ purchasing errors	-393.75	-393.75
Need for upgrade of billing system	-150	-150
Increased cost of vending stationery	-3,675	Not applicable
Cost of additional transformers	-9,883.03	-9,883.03
Total cost per month	**193,126.78**	**186,935.53**
Cost of damaging meter	2600	1900
Cost of power theft	22,247.46	22,247.46
Increased revenue collection	3,024,000.00	2,268,000
Total monthly benefits	3,048,847.46	2,292,147.46
Net benefit for Northern Area	**2,855,720.68**	**2,105,211.93**

Source: Appendix D

Note: the above estimation of cost items is based on the present value. Straight line depreciation method by matching principle was used in determining the cost of meter installation per month and the cost of re-wiring of rooms per month.

4.2.0 RESULTS:

4.2.1 Analysis of Variance:

Of the eight stations all indicated an increase in consumption except Bimbilla. The average increase in electricity consumption was 64.54%. However only 35.32% of accounts of the data on non compound houses, which is the reference, indicated an increase in consumption.

For effect of time elapsed on consumption:

The calculated value of F with degrees of freedom (11, 77) was 0.05.

The value of F from the tables for 5% level of significance was 1.92. (Appendix C).

The calculated value of F for effect of time elapsed was less than the table value, 0.05< 1.92.

For effect of locality i.e. station on consumption:

The calculated value of F with degrees of freedom (7, 77) for effect of station was (0.02).

The value of F from the tables for 5% level of significance was 2.13.

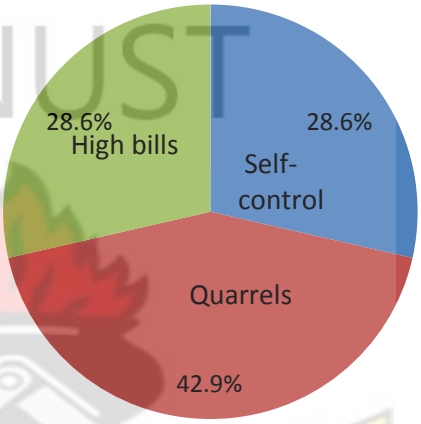
The calculated value of F for effect of locality was less than the table value, 0.02< 2.13.

4.2.2 Community Survey:

In the survey 84.6% of customers indicated that consumption was reduced when a separate meter was provided to them. Another finding was that 73.3% of customers also preferred that individual tenants should be given meters, as opposed to groups of tenants being given. Furthermore 86.6% of customers said that cooperation among co-tenants improved after

separate meters were provided to some tenants. On type on meter, 69.2% of customers said they preferred prepayment to the credit metering. There were three main reasons why tenants wanted a meter to themselves. The ratios of these reasons are presented in a pie chart 4.1 below.

Figure 4.1: Reasons for needing meter



Source: Results of Customer Survey.

4.2.3 Separation effect on Unit Cost of Electricity

In 48% of the sample studied, the unit cost reduced but increased in 52% of the cases.

4.2.4 PURC Tariff Structure and Compound Houses:

When the consumption per tenant of the parent meter before separation was divided by the number of meters and the result applied on the 2011 PURC tariff, it was realized that in 41.4% of the houses, each tenant paid more than when the total consumption is billed for them to share. (Table 4.7).

4.2.5 Cost- Benefit Analysis

(a) For the tenant:

Total cost to install a separate meter per month	GH¢	-6.68

(b) For the utility:

Total cost per month		
Credit meters	GH¢	-186,935.53
Prepaid meters	GH¢	-193,126.78
Total monthly benefit		
Credit meters	GH¢	2,292,147.46
Prepaid meters	GH¢	3,048,847.46
The net benefit per month.		
Credit meters	GH¢	2,105,211.93
Prepaid meters	GH¢	2,855,720.68
Cost per month spent on each tenant by utility		
Credit meters	GH¢	-0.39
Prepaid meters	GH¢	-0.41

4.3.0 DISCUSSIONS:

4.3.1 Analysis of Variance:

In analysis of variance, the F value calculated for passage of time was less than the F tabulated i.e. 0.05< 1.92 at 5% level of significance. Therefore we accept the primary null hypothesis H0: there is no difference in levels of consumption from month to month over time.

The F value calculated for effect of station was less than the F value tabulated i.e. 0.02< 2.13 at 5% level of significance. Therefore we accept the secondary null hypothesis H0: there is no difference in consumption patterns from station to station.

The average increase in electricity consumption among separately metered compound houses was 64.54%. This is to say that though there were no changes in consumptions as a result of differences in time or location, there were increases as a result of separation. This is corroborated by the results in the reference data which indicated that in only 35.32% of the reference accounts was there an increase.

4.3.2 Community Survey:

The result of the survey on consumption is in conflict with that of the ANOVA study. The respondents could be of the view that their consumption was reduced when they were given a separate meter by assumption and not by serious consideration. What is depicted by ANOVA means that there is suppressed demand for electricity in compound houses where there is shared metering.

Though the results preferred that individuals should be given the separate meters, it is currently more practicable for the utility to give the meters to groups of tenants considering the trend of meter availability.

Cooperation among tenants is very important since it enhances the well- being of the individual, development and could have a bearing on life expectancy.

Just as tenants in the survey preferred prepayment metering so does NED. The advancement in technology is really pushing in the direction of the use of prepayment metering. With time the credit meters will become old fashioned.

4.3.3 Separation effect on Unit Cost of Electricity:

It was not obvious that a reduction or increase in unit cost of electricity was closely dependent on level of consumption or number of separate meters installed in a particular compound house. However table 4.10 below slightly represents the nature of unit cost of electricity in the study.

Table 4.10: Nature Of Unit Cost Of Electricity

Consumption	Separate high	Separate low
Parent high	Depends on number of separate meters and level of consumption	Mostly lower but number of separate meters may influence
Parent low	Higher	Depends on number of separate meters and level of consumption

Source: NED Customer Billing Management System

4.3.4 PURC tariff structure and compound houses

It was realized that in 58.6% of the sample, the amount was lower when the consumption was shared before calculation of the bill, than when the bill was computed before sharing it among tenants. It was also evident that the higher the compound house consumption, the better it was for the tenants to be provided with separate meters.

4.3.5 Cost- Benefit Analysis

There was no data on the proportion of compound houses to the total population of customers. A count of all compound houses is required to establish the right percentage. Seventy five (75%) percent was however estimated by a quick observation. Appendix D

There was no data as well on the proportion of commercial losses to technical losses. Fifty percent (50%) was estimated as the proportion of energy theft in the losses. Appendix D

The life span of the assets such as transformers, meters and wiring were taken as thirty (30) years each. Matching principle was used to calculate depreciation on the cost of these assets in order to carry out the analysis in the present value.

(a) For the tenant:

The negative sign in the total cost of installation of separate meter indicates that no financial benefit was achieved by the compound house tenants. The research indicates that tenants rather increase their energy consumption when given their own meters. Therefore the benefits for them

are not financial but rather social. On the contrary a tenant rather spent GH¢6.68 extra monthly on electricity in real terms.

(b) For the Utility:

If every family is given a meter the incidence of power theft through meter bypassing will be greatly reduced in addition to an increased pattern of bill payment. The cost per month spent on each tenant by the utility to install credit and prepaid meters for all tenants is GH¢0.39 and GH¢0.41 respectively. The net benefit in installing credit meters for each tenant in Northern Area is GH¢ 2,105,211.93 per month. The net benefit in providing tenants with prepaid meters is higher at GH¢2,855,720.68. This represents substantial revenue gain to the Area. The inertia in getting 472,500 meters for this purpose are the capital cost and the fact that the department (NED) will need to take similar measures in other Areas.

This revenue gains in both credit and prepaid meter installations are positive based on the finding that tenants rather increase their energy consumption averagely by GH¢6.40 when given their own meters. The net benefit to the Area will be negative if the converse happens in both cases.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1.0 Summary of main findings

According to the ANOVA studies, electricity consumption levels in compound houses did not change as a result of time progression. There was also no difference in consumption patterns of compound houses from one station to the other. Though there were no changes in consumptions as a result of differences in time or location, there were increases as a result of separation. This was corroborated by the results in the reference data which indicated that in only 35.32% of the reference accounts was there an increase. Therefore the benefits of separate metering for tenants are not financial but rather social.

However the result of the survey on consumption is in conflict with that of the ANOVA study. The respondents could be of the view that their consumption was reduced when they were given separate meters by assumption and not by serious consideration.

In the survey 86.6% of customers said that cooperation among co-tenants improved after separate meters were provided to some tenants. It was also evident that the higher the compound house consumption, the better it was for the tenants to be provided with separate meters.

It was not obvious that a reduction or increase in unit cost of electricity was closely dependent on level of consumption or number of separate meters installed in a particular compound house.

5.2.0 Conclusions

Tenants who were provided with separate meters tended to increase their electricity consumption. They however preferred to be provided with separate meters according to the survey. Therefore the benefits of separate metering for tenants are not financial but rather social. There was no energy conservation issue in the study because it was realized that tenants rather increased the use of electricity when given separate meters. This indicates that there is suppressed demand in compound houses.

The study really supports the NED policy that as the consumption of compound houses increase, the tenants should be considered for provision of separate meters at some predetermined point.

The unit cost of electricity vis-à-vis separate metering and the March 2011 PURC tariff structure was not affected.

There is a weak difference in billing between sharing the units among the tenants before billing or billing them before sharing the cost.

The utility NED will benefit financially from implementing separate metering. The inertia in getting 472,500 meters for this purpose are the capital cost and the fact that the department (NED) will need to take similar measures in other operational Areas.

5.3.0 Recommendations

As the cost of provision of the meters to about 472,500 tenants will be burdensome to NED, it should start by providing one meter to smaller groups of tenants in each house.

Further research work and studies are required into the proportion of customers that are in compound houses and the number of tenants per house. This will be useful in determining a tariff suitable for both customers and the utilities during negotiations with the PURC.

A more thorough study into billing (sharing of accumulated consumption before or after billing) of compound house tenants is recommended for the PURC tariff setting. It was realized that in 58.6% of the sample, the amount was lower when the consumption was shared before calculation of the bill, than when the bill was computed before sharing it among tenants.

An equitable way of sharing the common bill in compound houses is an intervention that will minimize the quarrels by tenants. This topic needs further studies.

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APPENDICES

APPENDIX A:- QUESTIONNAIRE

A. Customers on Separate meters

1. Is there a difference in the way you use electricity now that you have a separate meter than when you were sharing a meter? Yes / No

2. Have you increased your electricity consumption now that you have a meter to yourself? Yes / No

3. Did you feel you should now use electricity the way you liked? Yes / No

4. Do you spend more on electricity than you did when you were sharing a meter?

5. Did you buy more appliances that use electricity after you were given a separate meter?

6. Have you ever cheated the electricity company, VRA?

7. Have you ever been disconnected? Yes / No

8. What else did you buy after you were given a separate meter?

   (a) TV (b) Electric Cooker (c) Water heater (d) Fridge (e) A/C (f) Other

9. Have you benefited by the use of the separate meter? Yes / No

10. Do you prefer a prepayment meter?

11. What caused you to go for a separate meter?

    (a) I was paying too much for electricity

    (b) We were quarreling over electricity bills

(c) I wanted to have control on how much I spend on electricity

(d) Other reasons

12. Is it a tariff increase that has caused your bill to increase or not?

13. Are you on the parent meter?

14. After your neigbours acquired separate meters what was the effect on your expenditure on your electricity?

(a) The same (b) it increased (c) it reduced

B. Customers on Parent Meter:

1. Did the migration to the separate meter by the other tenants affect you?

2. Was the effect positive or negative?

3. Are there still more than necessary tenants on the parent meter?

4. Did the cooperation between tenants on the parent meter become better after others moved to separate meters?

5. Did your consumption (use of appliances) increase after others moved to separate meters?

6. Do you think the separate meters should have been given to groups of tenants in the house instead of individual tenants?

7. If yes, why?

(a) It will reduce the pressure of demand for separate meters on VRA

(b) More tenants will benefit from reduced expenditure on electricity

(c) It will not bring independence

8. Are you unhappy because others were given separate meters?

9. If yes why?

   (a) It makes me jealous

   (b) They left their old bills on the parent meter

   (c) I also wanted a separate meter and did not get

   (d) It has disturbed our payment plan

APPENDIX B

Approved Tariff March 1, 2011 to May 31, 2011

Customer **Tariff Category**	**Tariff Blocks**	**A** **By PURC March, 11 GH¢ per Kwhr**	**B** **Total Subsidy Mar-11**	**C** **Subsidised Tariff March 1,2011**
RESIDENTIAL	0-50 (Exclusive)	**0.0950**	**0.0163**	**0.0787**
	50-51	**0.1595**	**0.0413**	**2.0932**
	51-150	**0.1595**	**0.0413**	**0.1182**
	151-300	**0.1595**	-	**0.1595**
	301 - 600	**0.2070**	-	**0.2070**
	600+	**0.2300**	-	**0.2300**
	Service Charge (0-50)*	**1.0000**		
	Service Charge (51-99999)	**1.5000**	-	**1.5000**
NON RESIDENTIAL	0-300	**0.2293**		**0.2293**
	301 - 600	**0.2440**		**0.2440**
	600+	**0.3850**		**0.3850**
	Service Charge	**2.5000**		**2.5000**
SLT-LV				
Capacity Chg(¢/kVA /month)	MD	**14.0000**	-	**14.0000**
Energy Chg (¢/kWh)	0-999999	**0.2390**	-	**0.2390**
Service Charge (¢/month)	Service Charge	**14.0000**	-	**14.0000**
SLT-MV			-	-
Capacity Chg(¢/kVA /month)	MD	**12.000**	-	**12.0000**
Energy Chg (¢/kWh)	0-999999	**0.185**	-	**0.1850**
Service Charge (¢/month)	Service Charge	**14.000**	-	**14.0000**
SLT - HV)			-	-
Capacity Chg(¢/kVA /month)	MD	**12.000**	-	**12.0000**
Energy Chg (¢/kWh)	0-999999	**0.170**	-	**0.1700**
Service Charge (¢/month)	Service Charge	**14.000**	-	**14.0000**
HV-Mines			-	-
Capacity Chg(¢/kVA /month)	MD	**14.000**	-	**14.0000**
Energy Chg (¢/kWh)	0-999999	**0.270**	-	**0.2700**
Service Charge (¢/month)	Service Charge	**15.000**	-	**15.0000**
NOTE: GOG and Utility Subsidies have been taken off except the 2007 subsidy Service Charge for life Line Customers is now GH¢1.0 and the rest of Residential as Gh¢1.5				

APPENDIX C

F Table for alpha=0.05																			
df2/ df1	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**15**	**20**	**24**	**30**	**40**	**60**	**120**	**INF**
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54	241.88		243.91	245.95	248.01	249.05	250.10	251.14	252.20	253.25	254.31
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40		19.41	19.43	19.45	19.45	19.46	19.47	19.48	19.49	19.50
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79		8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96		5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74		4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.37
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06		4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64		3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35		3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14		3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98		2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85		2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75		2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67		2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60		2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54		2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49		2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01

17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45		2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41		2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38		2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35		2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32		2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30		2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27		2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25		2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24		2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22		2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20		2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.67
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19		2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.65
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18		2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16		2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08		2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99		1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
77							2.13				1.92									
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91		1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
inf	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83		1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00

APPENDIX D

(b) For the utility:

b (i) by using credit meters

Cost Items	Unit	Per Item	monthly GH¢)
Cost of meter reading *Average meter reader commission is GH¢200.* *Each reader covers 3000 meters in 10-day cycle* *Estimate that 75% of credit meter customer accounts are for compound houses, ie 67,500.* *Also that average number of families per house is 7.* *Number of new accounts to be added is therefore 472500*	Sgl	0.067	31,500p
Cost of installation of separate meters *Life span of meter is taken as 30 years.* *Estimated number of families to be given meters is 472500. Cost of meter GH¢95* *(Depreciation by matching principle)*	Sgl	95	124,687.50p
Cost of billing paper *Northern Area uses 75 packets of paper per month for about 95000 customers.*	pkt	39.80	15,671.25p
Cost of inputting data *Average inputting cost per clerk is GH200.* *The number of clerks required will be 525% of present number ie 27.*	GH¢	0.011	5,250p
Need for additional transformers - *Increase in energy, 74.78kwh, size of transformer, 200KVA* *Number of transformers,307. Cost of a transformer, GH11600* *Life span, 30 years. (Depreciation by matching principle)*			9,883.03p
Increase pressure on Cash points *Add 525% of account clerks since additional population is approximately 5.25times the present customer population.*	Clerk	1600	8,400p
Increased billing errors due to human errors *Time spent on each adjustment is 20 minutes.* *Present number of bills adjusted per month is 40.* *Number of new accounts to be added, 472500*	Adj	2.5	393.75p
Need for upgrade of billing system *Twenty seven computers to be added.* *(Over 30 years, depreciation by matching principle)*	PC	10000	150p

Total cost per month	**-**	**238,402.50**
Cost to be incurred per month per family by NED	GH¢	0.50

The major benefits for the utility are as follows.

Cost of damaging meter *About 20 meters are damaged monthly*	Sgl	95	1900p
Cost of power theft *This is taken as the energy losses 18%. Say 50% is due to power theft. Billed energy for March 2011 is GH¢202,699.13*	Loss	18	22,247.46p
Increased revenue collection *Average monthly increase in electricity expenditure per new account as a result of separate metering, GH6.4. Say average revenue collection rate is 75%. Number of new accounts added 472500.*	GH¢	4.8	2,268,000p

Total monthly benefits for providing all families with meters 2,292,147.46

The net benefit for Northern Area is 2,292,147.50- 238,402.50= GH¢2,053,744.96 per month.

b (ii) by using prepaid meters

Cost Items	**Unit**	**Per Item**	**monthly GH¢)**
Cost of installation of separate meters *Life span of meter is taken as 30 years. Estimated number of families to be given meters is 472500. Cost of meter GH¢130*	Sgl	130	170,625
Need for more power generation infrastructure *No additional generation will be required Since Bui and thermal expansion plans are being considered for other reasons.*	-		-
Increase pressure on Cash points *Add 525% of account clerks since additional population is approximately5.25times the present customer population.*	Clerk	1600	8,400
Increased cost of vending stationery *Add 525% of present expenditure since additional population is approximately5.25times the present customer population.*	GH¢	700	3,675

Increased purchasing errors *Time spent on each adjustment is 20 minutes.* *Present number of bills adjusted per month is 40.* *Number of new accounts to be added, 472500*		2.5	393.75
Need for upgrade of billing system *Twenty seven computers to be added.*	PC	10000	150
Total cost per month	**-**	**-**	**235,593.75**
Cost to be incurred per month per family by NED	GH¢	0.49	

The major benefits for the utility are as follows.

Cost of damaging meter *About 20 meters are damaged monthly*	Sgl	130	2600
Cost of power theft *This is taken as the energy losses 18%. Say 50% is due to power theft. Billed energy for March 2011 is GH¢202,699.13*	Loss	18	22,247.46
Increased revenue collection *Average monthly increase in electricity expenditure per new account as a result of separate metering, GH6.4.* *Say average revenue collection rate is 100%.* *Number of new accounts added 472500.*	GH¢	4.8	3,024,000.00

Total monthly benefits for providing all families with meters 3,048,847.46

The net benefit for Northern Area is 3048847.46 - 235,593.75= 2,813,253.71 per month.

APPENDIX E

TAMALE	SALAGA	DAMONGO	SAVELUGU	GUSHEGU	
201-07549-0	205-02040-0	20602119-0	203-006250	207000780	207002560
201-11513-0	205-02040-0	206-02215-0	203-043780		207029590
	205-04143-0	206-00392-0	203-016260	207028800	207005140
201-21587-0	205-02038-0	206-01681-0	203-042250	207001280	207020620
	205-03171-0	206-02538-0	203-030070		
201-31480-0	205-03910-0	206-00267-0		207019880	207021770
201-37620-0	205-00261-0	206-02446-0	203-042510	207001280	207021460
201-41757-0	205-03786-0	206-00096-0	203-005330		
201-04331-0	205-04056-0			207007200	207027730
	205-00367-0	206-02230-0	203-036140	207019880	207028720
201-43731-0		206-02117-0	203-041410	207021250	207000830
201-28313-0	205-03740-0		203-004140		
	205-03807-0	206-02482-0		207029230	207021150
201-35116-0	205-04065-0	206-02486-0	203-032250	207002660	207002640
201-15905-0	205-02747-0	206-00568-0	203-009830		
				207007100	207005970
201-13465-0	205-00308-0	206-02216-0	203-041860	207021260	
	205-03492-0	206-02411-0	203-016320		207021760
201-41010-0		206-00238-0		207029030	207005400
201-41011-0	205-00313-0	206-02315-0	203-035120	207021540	
201-41371-0	205-02551-0	206-02523-0	203-005520		207021660
201-37510	205-00257-0	206-01375-0		20702987	207000640
			203-043740	207029880	
201-39490-0	205-01004-0	206-02551-0	BIMBILLA	207020560	207021590
201-39491-0	205-04438-0	206-00332-0	210-008930		207007490
201-39493-0		206-00302-0		207001010	
201-37894-0	20500040-0	206-02448-0	210-042260	207001260	207028270
	205-04119-0	206-02598-0	210-006270		207000370
201-42558-0	205-01021-0	206-00506-0		207007190	
201-42658-0			210-040590	207021750	207028290
201-34978	205-03189-0	206-02621-0	210-042300	207027790	207000780
	205-03306-0	206-01412-0		207029350	
201-34979			210-047130	207029500	207028800
	205-00084-0	206-02349-0		207009880	207002090
201-46896-0	205-03676-0	206-01121-0		207024730	
201-33205-0			KETE KRACHI	207009890	207017800
		206-02198-0	211001760	207029120	207002630
201-33204		206-02511-0	211056560	207018490	

201-33206-0		206-00221-0	211030090	207029210	207028430
201-14380-		206-02344-0	211056730	207029640	207006440
		206-00067-0	211056740	207000840	
201-27777-0		206-02365-0	211056750	207007070	207024830
201-32597-0		206-02626-0	211008730	207009810	207001500
201-38175-0		206-02665-0		207001800	
201-10731-0		206-00038-0	211056030	207017820	207018730
201-12992		206-02172-0		207029580	207001080
		206-02722-0			
201-19155-0		206-00127-0			207029180
		206-02202-0			207001300
201-39014-0		206-02203-0			
201-46799-0		206-02269-0			207019810
201-46904-0		206-01499-0			207002870
201-02257-0		206-02660-0			
		206-01078-0			207029260
201-02258-0		206-02605-0			207000950
		206-00100-0			
201-42531-0		206-01906-0			207021460
		206-02704-0			207024720