ENHANCED COST CONTROL SYSTEM FOR MONITORING ELECTRICITY CONSUMPTION IN NIGERIA

[1]Nwabueze, C. A., [2]Anyanwu, M. C.
[1]Department of Electrical/Electronic Engineering, Chukwuemeka Odumegwu Ojukwu University, Uli, Anambra State.
[2]Computer Programme, National Mathematical Centre, Abuja.
Email: [1]canwabueze@yahoo.com, [2]anyanwuchima94@yahoo.com

Abstract

Electricity demand in households resulting from unpredictable consumption pattern has been serious concerns in Nigerian power industry. Existing metering systems have not addressed the various challenges of enabling daily tracking of power usage patterns in homes. This work presents collocation Cost Control Smart Metering System (CCSMS) for monitoring electricity consumption. The main limitation of existing traditional meters is that they do not provide sufficient real time information to the consumers. In this work, a collocation cost control model using a smart metering system that helps consumers to understand their instantaneous consumption profile was developed which will facilitate demand side response in consumers' homes. Proteus ISIS logic was employed to characterize the behaviour of the system, while fuzzy logic intelligent algorithm was used to provide a mechanism for the metering intelligence using the process variables (current, voltage, load demand and recharge units). The cases for compact and non-compact responses on the cost and average power consumed were demonstrated. The results showed flattening consumption costs for corresponding average power consumed in an hourly scale. From the study, it was observed that for non-compact distribution, over 2500kwh of power was lost, while for compact distribution, the power loss was minimal (less than 100-150kwh). Consequently, this work established the need for using a collocation CCSMS in monitoring power consumption data in various households and interpretation of the data for hourly measurement. This has the implication of assisting home users to practically enforce demand side management thereby encouraging cost saving.

Keywords: Collocation, Cost Control, Consumption Cost, Metering Intelligence, Compact and Non-Compact distribution.

1. INTRODUCTION

The Cost Control Smart Metering System (CCSMS) for monitoring electricity consumption by consumers in the distribution system is an enhance paradigm that seeks to open new research dimensions for utility management. Electric energy meters and direct billing interface between utilities and consumers has undergone several advancements in the last decade.

A CCSMS enables power utilities to collate electricity bills from the consumers prior to its consumption. The prepaid meter is not only limited to Automated Meter Reading (AMR) but is also attributed with prepaid recharging ability and information exchange with the utilities pertaining to customer's consumption details. The idea of prepaid metering will be very important for the new research fields of Micro-grid and Smart Grid and is an inevitable step in making any grid smarter than it is now. Literature has witnessed quite an amount of work in this area. The use of electronic token prepayment metering has been widely used in the United Kingdom for customers with poor record of payment. (Adegboye, K.A.(2013)).

Electronic meters measure energy using highly integrated components or other customized integrated circuits. These devices digitize the instantaneous voltage and current via a high-resolution sigma-delta ADC (analog to digital converter). Computing the product of the voltage and current gives the instantaneous power in watts. Integration over time gives energy used, which is usually measured in kilowatt hours (kWh). The conventional electromechanical meters are being replaced by new electronic meters to improve accuracy in meter reading.

Electricity consumers and utility companies are continually advocating ways to improve the grid for: intelligent and real time monitoring of electric power network; detection of theft and leakages; outage report; automated bill generation; bill assessment and bill payment; interactive platform between consumers and utility companies and provision of consumers and businesses with energy management tools
and information, etc. These operators are advocating ways to improve the grid in parts and in its entirety, making it smarter and more intelligent than it is at present. However, the metering of such intelligent and robust system requires an architectural design that will help utility vendors provide efficient services as well as monitor consumer consumption patterns for expansion/optimization of the grid network. This work looks at the peculiar Nigerian distribution metering model to enhance the system for maximum performance.

2.0 **LITERATURE REVIEW**

Various works on metering systems have been proposed. Rohini, et al, (2014), explained that energy meters in India have dominantly been electromechanical in nature but are gradually being replaced by more sophisticated and accurate digital and electronic meters. Since a high percentage of electricity revenue is lost to power theft, incorrect meter reading and billing, and reluctance of consumers towards paying electricity bills on time, the use of a prepaid Energy Meters was advocated for recovering loss revenue.

The work in Ndinechi, et al (2011), proposed an electric meter reading system that has a low cost power requirement. The work used the PIC18F4620 as the MCU, at the idle and sleeping state, which can minimize the power consumption of the system, and used CC2430 chip which conforms to ZigBee protocol stack standard, and it needs a few external equipment's, stable performance. The paper finally gave functional description of the system without and simulation or design implementation prototype.

In a similar proposal, the authors in Clements, et al (2009), explained that the traditional method for retrieving the energy meter data and billing is not convenient and time consuming, and hence proposed a billing strategy via SMS which is convenient and reduces manpower.
The system was meant for remote monitoring and automatic tariff updating. This system gives the information regarding meter reading, power cut, total load used and tempering on request or regularly in particular interval through SMS. This information is being sent and received by concerned energy Provider Company with the help of Global System for Mobile communication (GSM).

From the reviewed works, there is need to use collocation metering to monitor the network distribution system. This dissertation therefore present an energy metering system using collocation system in monitoring cost of power consumed in the Nigerian environment.

3.0 METHODOLOGY

3.1 Proposed Collocation Cost Control Metering System Controller

In this work, a collocation intelligent metering detection system (CIMDS) with instantaneous SMS alert is proposed. The set up contains an Intelligent Statistical Meter(ISM) placed at the transformer end or on Electric Pole. It communicates with the various consumers meters linked with it through RF and GSM technologies. It monitors and continuously sums up the total energy consumption measurements from various consumers' meters in a designated region and sets it as a reference value.

Whenever this reference consumption value is exceeded, a metered alert is sent to the utility company as well as to the end user device. The entire system is modelled and simulated in Protus ISIS environment, authenticated with fuzzy logic. A review of smart metering in this regard will be carried out.

The energy consumption is being calculated using the Energy Acquisition Module (EAM) and Microcontroller (AT89C52). The Microcontroller based digital prepaid energy meter system can be divided into eight parts as Voltage sensor, Current sensor, Energy Acquisition Module (EAM), Microcontroller, Smart Card and its Communication with Office Terminal/ Smart Card Programmer, Relay / Isolation Control Unit, Display Unit and Power Supply Unit. In the following circuit diagram, Vcc represents the positive supply and GND represents ground. The hardware description of the various parts is separately introduced as follows:

i. Voltage and current Sensors: -

In this voltage is considered as constant and current is measurement for consumption in terms of power as

$$P=I^2R \text{ watt} \qquad (3.1)$$

This measured current or power is converted into pulses by ADC (Analog to Digital Converter) measured by counter and temporary stored in the Microcontroller8051 memory for compare with balance.

Energy Acquisition Module (EAM) is biased around the neutral wire and a resistor divider is used to provide a voltage signal that is proportional to the line voltage. A voltage divider is made in combination of 1 MΩ resistor and 1 kΩ resistor. The output voltage across the 1 kΩ resistor is applied to one of the Analog to Digital Converters.

For the current sensing, the total current is sensed using a current transformer and a shunt resistor. The Shunt resistor R_{shunt} and the current transformer are scaled such that a voltage signal of no more than 1V peak-to-peak is present at the input of ADC.

The voltage output from a calibrated Shunt resistor is connected with the neutral wire is applied to the other Analog to Digital Converters.

ii. The Energy Meter Module (EAM) has ADCs that digitizes current signals from the supply main. These ADCs have a sampling rate of 900 kHz. A high-pass filter in the current channel to the ADC removes any dc component from the current signal**: -**

- In this simulation we have used ADC804 IC

- ADC convert analog signal i.e. power into digital number or pulse.

- These pulses are given to AT89C52

This eliminates any inaccuracies in the real power calculation due to offsets in the voltage or current signals. The real-power calculation is derived from the instantaneous power signal. The instantaneous power signal is generated by a direct multiplication of the current and voltage signals. In order to extract the real-power component, the instantaneous power signal is low-pass filtered. The low frequency output of the Energy Meter Module is generated by accumulating this real-power information.

The output frequency is therefore proportional to the average real-power. This average real-power information can in turn be accumulated by a counter to generate real-energy information.

The electronic energy meter relies on an analog-to-digital conversion. This is done by Analog to Digital Converter (ADC). The ADC takes samples or “snap shots” of the analog signals at discrete instances of time. These “snap shots” or discrete time signals are in turn converted to numeric values by the ADC.

The ADC requirements for energy metering are:

- The relatively wide dynamic range and the accuracy requirements of the application, the resolution of the ADC needs to be high resolution
- A Sampling rate of at least 2 to 4kSPS (kilo Samples per Second) is required. A basic rule of sampling theory states that the rate (frequency) of sampling must be at least twice the highest frequency content of the signal.

This is called the Nyquist rate. Energy metering specifications call for accurate measurement of frequency content up to the 20th harmonic which is 1 kHz or 1.2 kHz depending on the line frequency

- Low cost. The solution must be low cost because the energy metering application is particularly cost sensitive
- The ADC must not consume excessive power. One of the challenging aspects of solid state meter design is the design of the power supply unit.

3.2 GSM-Based Relay Billing System

The block diagram of the GSM-Based interface is shown in Figure 3.1. It can work with three main parts, namely: The Digital Energy Meter, the GSM-Based Recharge Module and the Public Utility Control Centre (PUCC) server on the internet. In this regard, a Quad-band intelligent GSM/GPRS modem suitable for long duration data transmission is used to implement collocation metering system. In a unit, the GSM modem is connected to a microcontroller which would transmits data from a meter to internet and also receive commend from internet to energy meter. The modem will send unit or pulses (power consumption) on a regular interval or on a request.

AT commands set which stands for attention terminal are used by energy meter to communicate with the GSM Modem. All the meters communicate with each other via the GSM module.

3.3 GSM-Based Recharge System

In the model, the power utility sets the amount in the prepaid card to a measure that the consumer recharges the card to, called Recharged Amount (R_A). The tariff rates are already programmed and fed into the card. As the load is consumed, the meter sends the units consumed to the prepaid card which continuously converts these units into Expenditure (E) at each instant and then subtracts it from the Recharged Amount to obtain a Balance (B).

3.4 Digital Energy Meter: It contains a Metering IC which measures the current and voltage signals and generates instantaneous active power. The instantaneous active power values are continuously integrated to an active energy register, the value of which is periodically accessed by the microcontroller via SPI (Serial Peripheral Interface). The microcontroller uses the retrieved active register value to calculate the active power consumed.

A real time clock is also implemented on the microcontroller, which enables timestamps to be generated, so the synchronization between the PUCC server and the meter can be established.

The microcontroller is programmed to read data from the metering IC every second. The active meter of the metering IC is not reset after it has been accessed, thus when the microcontroller reads the data from the active register, this value is stored and then subtracted from the next reading to determine the actual instantaneous power value .The difference between the current and previous values is called the delta value. The active register of the metering IC also wraps around every 52 seconds and this is rectified in software. For each reading the new delta value is added to the previous delta values the accumulated is compared to a threshold value. The threshold value is the amount of energy measured by the meter before a pulse is generated. The threshold value is calculated by dividing the energy represented by a light emitting diode (LED) pulse by the energy per register count i.e
Figure shows the structure of the intelligent collocated metering which consists of the main intelligent statistical meter (ISM): This sums up the overall energy consumption in the network at a particular time. It compares the result obtained with the total actual metered energy consumption in the network. An SMS alert for on- site visit is triggered whenever there is a positive difference in value. This main meter is recommended to be placed at the user end or at transformer end. This meter also measures the energy consumed by the load connected to it. This measurement is called the metered energy.

Load: This is the true load (metered load) connected to the Load meter. Load 1, to load *N*. In our simulation context, the consumer loads includes: the chandeller, air conditioner, fan, etc. After the metering card recharge with energy units, the prepaid metering system for the electricity distribution system regulates the consumption and communicates its energy data to the web via a GSM module. The CCSMS is based on metered consumption detection method which involves using the sensing actuators to control the energy consumed by the loads below it.

By placing an intelligent statistical meter at a node of the residential power grid and that measure the consumption of branches or specific loads in the tree below, the system performs a metering comparison to check when the energy unit is exhausted. An SMS alert is automatically sent to the end user on site.

4.0 CCSMS Data Acquisition and Energy Calculation

4.1 Data Acquisition for Calculating Power

The Energy Meter IC AD7751 produces an output frequency that is proportional to the time average value of the product of two voltage signals. The input voltage signals are applied across pin 4, 6 and pin 8, 7 of Energy Meter IC. The Energy Meter IC also provides an output frequency at pin 22 of Energy meter IC interface is equal to the output power that can be calculated using an equation as

$$F = \frac{5.74 \times V_1 \times V_2 \times \text{Gain} \times F_{1-4}}{V_{REF}^2} \qquad (3.2)$$

Where, V_{REF}= Nominal reference voltage for Energy Meter IC = 2.5 volts, F_{1-4}=1.7, Gain=1, V_1= Voltage applied across pin 4 and 6 which is proportional to load current, V_2= Voltage applied across pin 8 and 7 which is proportional to line to neutral voltage. This output frequency is proportional to the real power information.
During calibration we have got the frequency:F=0.5 Hz against 1.5 kW load. When F= 0.5 Hz, then power=1500 Watt.
So for any value of the frequency at F (say F= X Hz), Power, P will be
$P = 1500*X/0.5 = 3000*X$ (3.3)

4.2 Algorithm For Energy Metering System At Consumer's End

1. Start
2. Initialize the display.
3. Decide whether the number of units in Microcontroller is sufficient or not. If the balance is insufficient then disconnect the load from supply otherwise connect to the load to supply.
4. Count the number of pulses initiated from EAM with the help of the internal counter when the load consumes power.
5. Measure time with the help of internal timer in AT89C52.
6. Calculate power, $P = 3000* X$ using this equation, where X denotes the frequency of pulses that is produced by the EAM.
7. Calculate energy using the following equation,
(3000*X *Sec)/ 3600000 Units
8. Store energy and power reading into the AT89C52 Microcontroller for future use.
9. Check whether the button for number of units recharge is pressed or not. If the button is pressed check whether a valid smart card is inserted or not. If the inserted card is valid then read, store and update the recharge information and display the update status on the LCD.
10. If the valid smart card is not inserted then repeat the step 3.

4.3 Energy Calculation

The complete equation for determining the energy or units consumed from Power, *P* is obtained as follows:

$$1WattSec = \frac{1kWsec}{1000} = \frac{1kWh}{1000x3600} \qquad (3.4)$$

$$Energy = \frac{P * Sec}{1000x3600} units$$

$$Energy = \frac{3000 * X * Sec}{1000 * 3600} units$$

Assuming a unity power factor for purely resistive loads, the Energy *E* in KWh per day is given by Equ 3.4.

$$E = \frac{Power\ (W) * Numberof\ Usage\ hours\ \ per\ Day\ (t)}{1000W\ per\ Kilowatt}$$

$$= \frac{P(W)*t(h/day)}{1000W/Kw} \qquad (3.4)$$

TheCCSMS uses Eqn 3.4 to compute the average power consumption per day. Now, from Equ 3.4, the Energy in Kwh = *(VI* t*)* = 250*24 = 6,000Wh. Now, let cost = 0.17 in Naira per *KWh*, be the cost of energy*/KWh*.

Considering the base calculations above, the cost per month = 180*KWh/Month* *0*.17KWh.* This gives the monthly cost as N30.6 per month.

The yearly cost = 65,700*KWh/year* *0.17*KWh*, giving N11,169 per year (ie if used daily). For the purpose of the implementation, the unit cost was used as *1N/KWh*

Also, the error associated with the energy measurement made by the percentage error of the meter ADC defined by Equ 3.5 which accounts for load compensation.

$$E\% = \left(\frac{Energy\ Registered\ by\ Meter\ ADC - True\ Energy}{True\ Energy}\right) \times 100\% \ (3.5)$$

5.0 SIMULATION RESULTS AND ANALYSIS

In this chapter was noted that the demand for electricity and its usage are constantly rising at a pace. The importance of abnormal variations in consumption has to be studied via a simulated procedure. Also, necessary steps must follow to adapt the changes in their patterns. After carefully integrating all the subsystems that made up the system, the entire system simulation ran and worked perfectly without errors. The fuzzy logic and Protus ISIS components will be discussed in this chapter.

5.1 Protus ISIS System Simulation Implementation and Testing

This work used Protus ISIS to implement the characterized collocation metering system owing to the functional limitation of existing simulation tools. After the various stages of design and analysis were carried out, the different modules were incorporated via Protus ISIS simulator. The modules/sections were simulated individually after which entire circuit which is the conglomeration of the individual sections was also tested. Each of the sub-system was developed. Adjustments were made to get exactly what the simulation is meant to achieve.

In this case, three prepaid cloud meters synchronously send data indicating the total number of energy units recharged at a given time, the units consumed and the units remain. All this is done over the internet virtual terminal and is computed in real time. This means that any point in time, the energy distribution company that makes use of this cloud facility can have an up to date real time or production values from the various prepaid meters. This design can easily be scaled up to have more meters sending data.

In the simulation context, the consumer loads includes: the chandelier, air conditioner, fan, etc. After the metering card recharge with energy units, the prepaid metering system for the electricity distribution regulates the consumption and communicates its energy data to the web via a GSM module. This work was done using a program description language to fully characterize the system while carrying out its implementation with Protus ISIS 7.6.

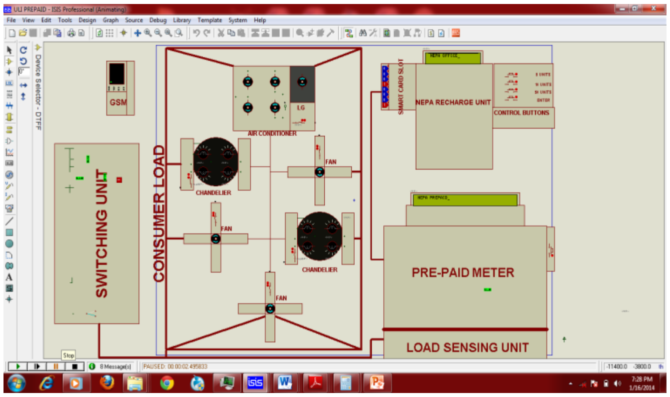


Figure 4.1: Shows the Snapshot capture of a Single metering unit on Proteus 7.6 when units is being loaded on the meter. After loading the unit, it now connects to the grid or supply.

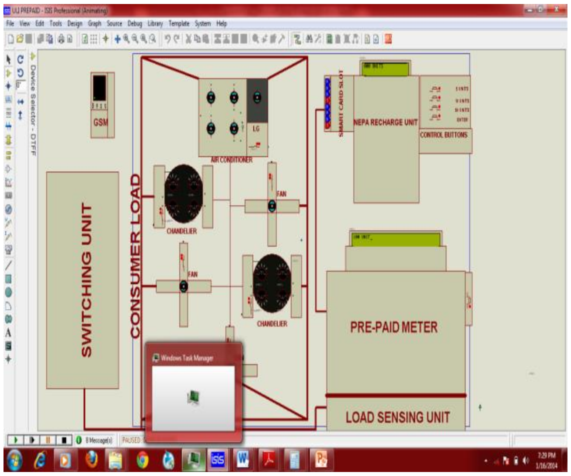
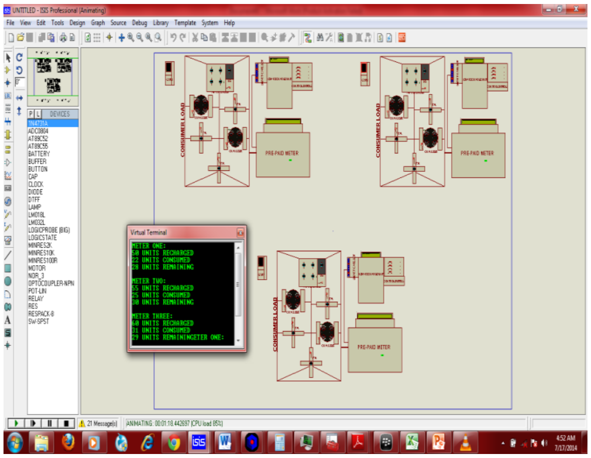


Figure 4.2: Shows the Snapshot capture of a Single metering unit on Proteus 7.6 when units is being used up by consumer loads, it then cut-off from the grid or supply.



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METER ONE:
50 UNITS RECHARGED
22 UNITS CONSUMED
28 UNITS REMAINING

METER TWO:
55 UNITS RECHARGED
25 UNITS CONSUMED
30 UNITS REMAINING

METER THREE:
60 UNITS RECHARGED
31 UNITS CONSUMED
29 UNITS REMAININGETER ONE:
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Figure 4.3:Snapshot capture of Single Metering Unit on Protus 7.6 at optimal active state. In this case, you now have access to manage your equipments for low and effective consumption.

Consequently based on the above observation, the duration of time over which the consumption curve should be flattened is estimated. This encourages consumers to recognise the significance of hourly duration for flattening the consumption at high prices. From all the choices and observations, the process to flatten energy consumption patterns can be achieved as follows. A period with increasing price for duration of 24 hours is selected.

The average of corresponding consumption values for 24 hour duration of increasing price is obtained and the previous values are replaced by this average.

Table 4.1: Average Power Consumption Profile

	Household1_Experiment		**Household2_Experiment**		**Household3_Experiment**		**Household4_Experiment**	
Time	Avg. Power (KWh)	Flat Consumption Cost	Avg.Power (KWh)	Flat Consumption Cost	Avg.Power (KWh)	Flat Consumption Cost	Avg.Power (KWh)	Flat Consumption Cost
1:00	435.04	435.04	43.42	43.42	25.35	25.35	225	225
2:00	836.51	836.51	83.87	83.87	47.96	47.96	408.8	408.8
3:00	1392.7	1392.7	121.5	121.5	70.49	70.49	605.3	605.3
4:00	1923.5	1923.5	164.5	164.5	90.21	90.21	776.4	776.4
5:00	2865.3	2865.3	224.8	224.8	115.6	115.6	1065.1	1065.1
6:00	3733.6	3733.6	275.5	351.7	158	158	1382.4	1496.8
7:00	4167.3	4167.3	390.6	484.5	211.7	211.7	2246.2	1969.4
8:00	4941.2	4941.2	538.5	650.8	264.9	264.9	2742.3	2528.4
9:00	5832.7	5832.7	887.1	835.3	326.7	326.7	3067.3	3105.6
10:00	6686.8	6686.8	1043.6	991.9	386.3	386.3	3459.3	3497.7
11:00	7148.2	7148.2	1141	1089.3	420.6	420.6	3805.3	3843.6
12:00	8196.9	8196.9	1229.9	1178.3	440.5	440.5	3958.5	3996.9
13:00	8965.7	8965.7	1313.9	1262.2	460.3	460.3	4333.9	4372.3
14:00	9371.5	9371.5	1447.3	1395.6	485.4	485.4	4663.4	4701.8
15:00	9924.2	9924.2	1531.1	1479.5	532.5	532.5	4977.4	5015.8
16:00	10485	10485	1586.6	1535	582	582	5180.7	5219.1
17:00	11274	11274	1638.5	1586.8	633.5	722.9	5513	5551.4
18:00	13700	13574	1694	1642.4	961.8	865.2	5795.6	5834
19:00	17212	16031	1764.3	1712.6	1050	1008.5	6193.6	6231.9
20:00	19576	18645	1834	1782.3	1160.7	1152.5	6708.4	6746.7
21:00	21255	21383	1892.5	1840.9	1258.5	1250.3	7180.2	7218.6
22:00	22089	22217	1940.1	1888.4	1350.8	1342.5	7762.2	7800.6
23:00	22675	22803	1990.1	1938.4	1457.3	1449	7953.7	7992
24:00	23461	23589	2031.9	1980.3	1544.1	1535.8	8231.6	8270

- The procedure is repeated if there is duration with increasing price through 24 hours duration on the same day for that particular household.
- From calculating average of high price consumption values, any cost deviation can be identified.

Graphical representations of different household patterns are shown below. Figure 4.4 consumption of household 1 to Figure 4.11 depicts a consumption profile that is increasing from 0:00 to 12:00 hour. The average of corresponding consumption from 0:00 to 12:00 pm on 24hourly scale duration is performed to achieve positive correlation. From the results obtained, it was found that as most of the users are now informed with prices, the graphical patterns of their consumption shows most of the households consume high energy peaks at high prices and varied consumption. Therefore, the outcome of the plots attempts to play a significant role aiming to distribute energy effectively. The graphical technique considered in the research is in response to the concerns in the electricity market determining the consumers to save money.

From the plots below, the values denoted in red corresponds to peak price hours obtained from the household while the blue colour depicts the average power. The variations help consumers to gain knowledge and encourage them to achieve immediate savings with benefits.

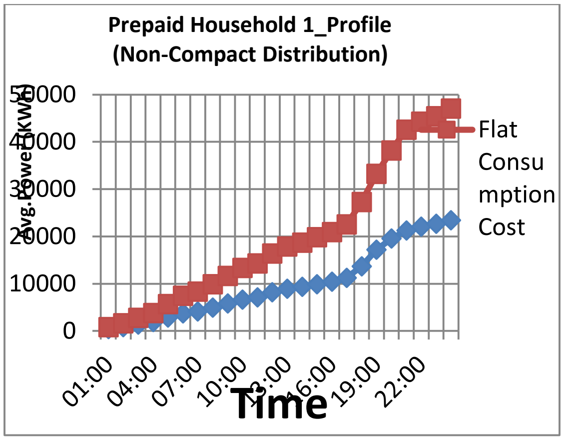

Figure 4.4: Non-compact behaviour of house1 on cost and average power consumed.

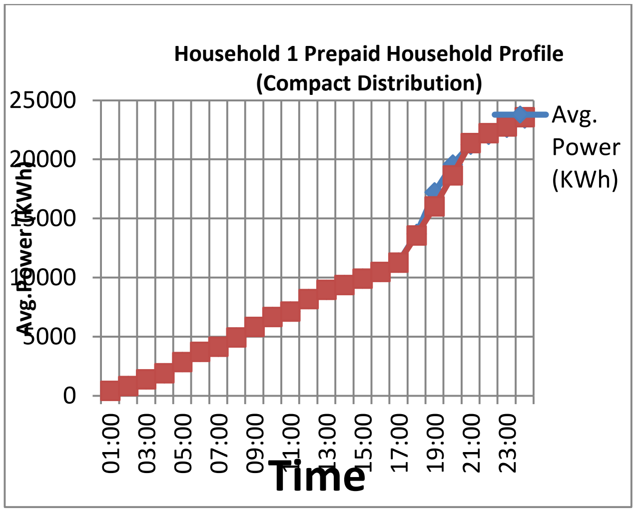

Figure 4.5: Compact behaviour of house1 on cost and average power consumed

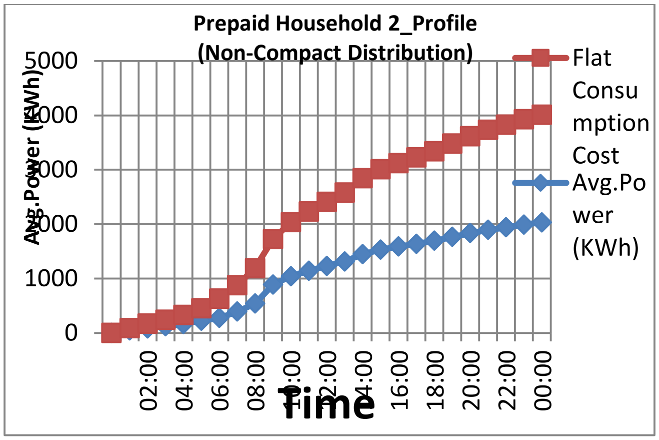

Figure 4.6: Non-compact behaviour of house2 on cost and average power consumed

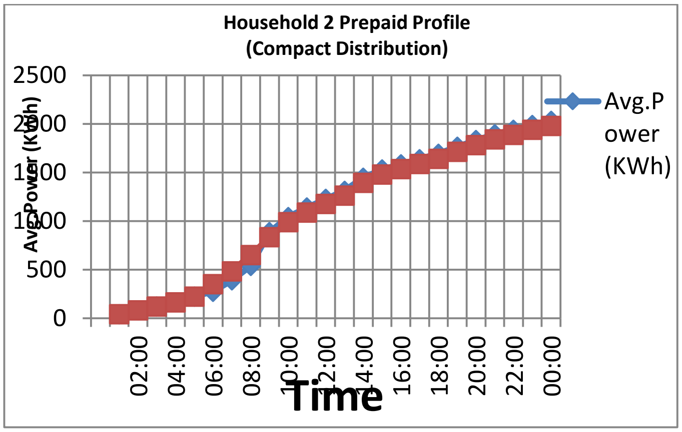

Figure 4.7: Compact behaviour of house 2 on cost and average power consumed

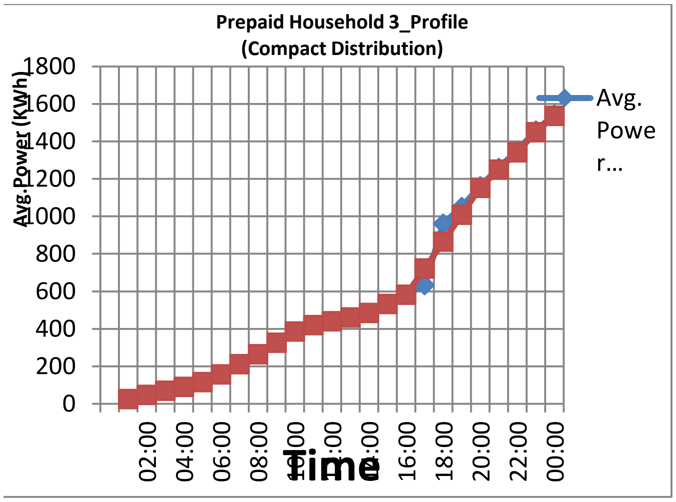

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Figure 4.8: Compact behaviour of house3 on cost and average power consumed

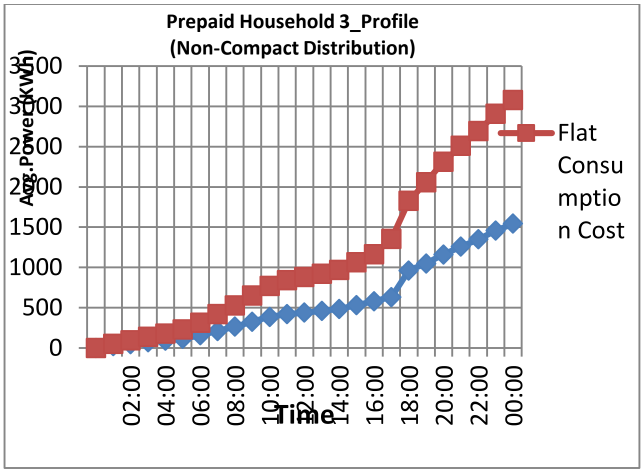

Figure 4.9: Non-compact behaviour of house3 on cost and average power consumed

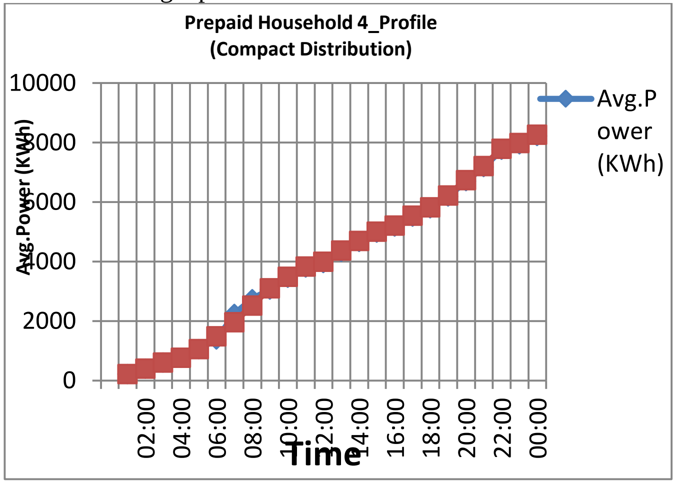

Figure 4.10: Compact behaviour of house4 on cost and average power consumed

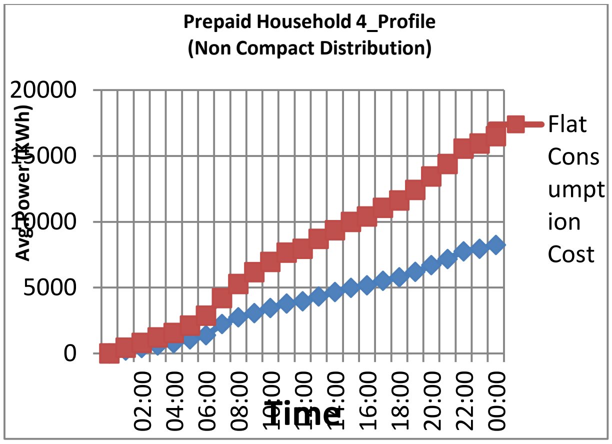

Figure 4.11: Non-compact behaviour of house 4 on cost and average power consumed

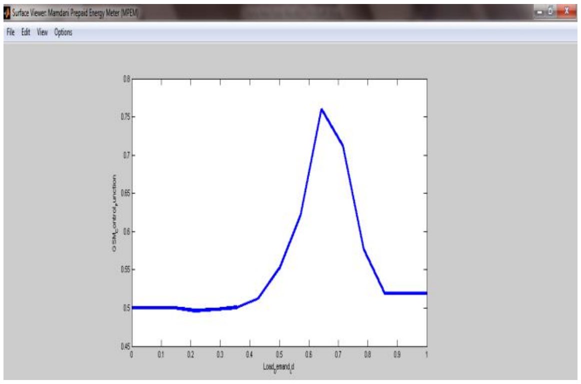

Figure 4.12: Cost control graph for load demand profile

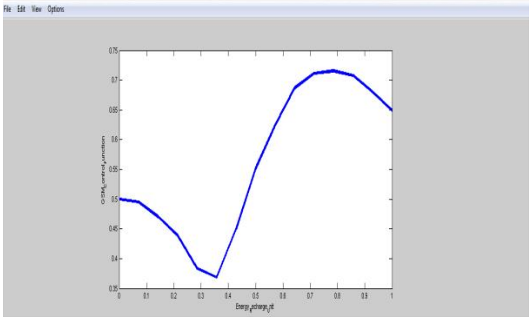

Figure 4.13: Cost control graph for Energy Recharge demand profile

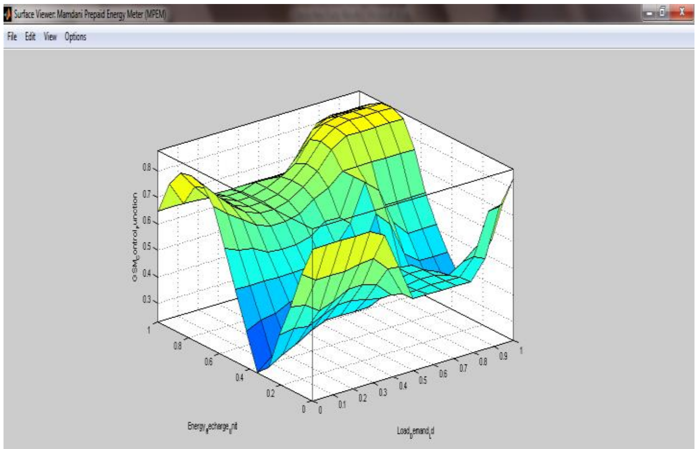

Figure 4.14: Control surface diagram for Energy Recharge and load demand profiles

5.1 Experimental Results

From these results, there is a strong correlation between the power consumed by the end user and the cost implication. For energy consumption, price is a prime factor followed to exhibit the behaviour of consumers. Hence, there is necessity of obtaining power consumed as well as the consumed price equivalent with reference to consumption patterns. The average power consumption during a month is computed. Through this computation, household experiments from the simulated template were derived in Table 4.1. It shows the time of consumption, the average power consumed and the flat costing based on 1unit for a KWh consumed. From the end user device, there is no delay, i.e. users do not have to wait for the next hour to see price and consumption. While the price is rising, the user tries to control the load. In particular, consumption peaks that occur with price peaks shall be avoided.

CONCLUSION

This work presented, analyzed and designed an enhanced collocation cost control system for monitoring electricity consumption in Nigeria for electricity distribution considering the end users. This was simulated with fuzzy logic and authenticated with Proteus ISIS 7.6 software. Due to the capital intensive nature of the system, a physical prototype was not produced, but following the simulated prototype, a physical version can be developed and applied.

The electric power sector and indeed the grid is witnessing great ideas and technologies to transform its generation, distribution, transmission and consumer components using intelligent Information and Communication Engineering infrastructure in order to render reliable, effective and efficient electric power to the ever growing consumer needs. Although some researchers propose a holistic and total overhaul approach in the implementation and transformation efforts of the present grid to the smart grid, some other researchers and indeed many countries don't completely subscribe to this. They therefore implement their belief that by making the individual grid components smart, the grid in its entirety becomes smart.

This work therefore lends its voice to the ever increasing ideas on the improvement of the electricity grid. It tapped into the smart grid concept and offered its idea to improve the consumer component of the grid which is more or less the most important component of the grid since all the other components work harmoniously to satisfy the needs of the consumer. The review works on metering systems provides a clear revelation of the effectiveness of the proposed system for consumers of the present Nigerian electric power system.

Finally, the proposed system has the potential to change the traditional billing system. The energy billing system may help the energy distribution companies to reduce costs and increase profits, to improve metering and billing accuracy and efficiency, and to contribute the energy in a sustainable way. The test result obtained by the model is satisfactory and found to be having very much less error in the experimental tolerance level. This has been observed that the system is stable and do not show any error or instability during its operation.

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