International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 8, pp: 656-666 www.ijaem.net ISSN: 2395-5252

Metering as a Tool for the Reduction of Non-Technical Losses in Yola Electricity Distribution Company

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Date of Submission: 01-11-2020 Date of Acceptance: 15-11-2020

ABSTRACT: World energy crisis are increasing globally which draws the attention of everyone towards production of sustainable energy. Non-Technical losses have been a problem in the Nigerian electricity power sector which is causing a huge loss in the industry, largely as a result of Government dominance prior to the total deregulation of the sector in 2013. This paper presents a practical cases of Non-Technical losses in Yola Electricity Distribution Company (YEDC), the negative effect of transmission and distribution losses on the quality and level of power generation, transmission and distribution network. Technical losses are considered as losses due to parameters of the transmission and distribution networks, whereas non-technical losses are sometimes termed as commercial losses, on the other hand come about as a result of energy thefts, customer accounting errors, improper billing, wrongful assessment of customer loads, un-metered customers and or errors in the metering platform. Three districts are considered, namely; Yola, Numan and Jalingo and proposing metering especially smart metering solutions in leveraging the epidemic of huge non-technical losses being incurred by YEDC which hitherto has not been proactive in managing the menace of non-technical losses within its system. Typical monthly bills versus the energy supply to the selected areas were considered.

Key words: Non-Technical Losses, Smart meter, DISCO, YEDC

I. INTRODUCTION

Metering as a topic is as wide as electrical engineering itself, because there is hardly anything worthwhile in electrical engineering which does not involve metering; this paper cover low voltage and the (11-33) KV electricity consumers with a view to ascertaining the grave effect of non-technical losses on the distribution networks and hence provide a solution to the incessant power supply currently being experienced due to misuse of the scarce power by the un-metered users. The areas ear-marked for this work are Yola, and Numan all in Adamawa State and Jalingo town in Taraba State as case study.

The history of Electrical Power Generation, Transmission and Distribution in Nigeria dates back to 1898 when actual power generation started in the municipality of Lagos. In 1929, the then Colonial Government established the Nigerian Electricity Supply Company (NESCO) in Jos, Plateau State with a total generating capacity of 4MW of Electrical Power, consequent upon this also, the Colonial Government established the Electricity Corporation of Nigeria (ECN) in the year 1950 promulgated by an ordinance No ECN 15 of 1950 [11]. This was with a view to harnessing and bringing together of all power generated by various units into a single grid system for easy control and distribution. With this zeal by successive Governments to meet up with the power needs of the populace a 132kv transmission path was constructed to Ijora Power Station connecting Lagos to Ibadan Power Station, this was achieved in 1962. In a similar manner, the Niger Dams Authority (NDA) was established in 1962 with the sole purpose to construct hydropower stations. The Dams of Niger Authority and the Electricity Corporation of Nigeria were merged in 1972 and was code named NEPA (National Electrical Power Authority) which has hitherto remained the dominant name for the supply of electricity in Nigeria [11].

The story of this body called NEPA cannot be anything different from other sister agencies of Government like the Nigeria airways,

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Nigeria postal services etc, which all collapsed due to mis-management and lack of foresight while NEPA at its inception could generate adequate power for the populace, a lot of it was dispensed as charity to most Government establishments especially the military and Para-military institutions with little or no regard to its expansion and the ever increasing demand [21]. Tangible expansion in volume, standard and access to better infrastructural services, especially electricity, which is fundamental/key to fast and sustained economic growth, and reduction of poverty in any nation, even though, for the past thirty years, inadequate quantity, quality and access to electricity services has been a worrisome issue in Nigeria, a country with about 200 million people with a majority living on less than N500 per day.

The crisis ravaging the Nigerian electricity industry had been somehow dramatic for a variety of reasons. The first is its persistence despite the enormous endowments of the nation with non-renewable and renewable primary energy resources. The resource endowments of crude oil and natural gas currently estimated at 35 billion barrels and 185 trillion cubic feet, respectively, are more than adequate to fuel much of Sub-Saharan Africa (SSA) energy demand for several decades [19]. Coal reserves are also substantial at 2.75 billion metric tons. Also, large amount of renewable energy resources including hydroelectricity, solar, wind and biomass energy are present [19].

The persistence of the crisis under successive governments seems to suggest that the adverse impact of the "curse of electricity" on socio-economic development and living standards was hardly appreciated. The prolonged dismal electricity industry performance has been the most intractable infrastructural problem and policy challenge in the last half a century. In recent years, there seems to be a better appreciation of the gravity of the infrastructure problem as apparent in various policy initiatives [25].

Factors Affecting Electricity Generation, Transmission and Distribution in Nigeria

A variety of factors are militating against the quantitative and qualitative generation of electrical energy supply in Nigeria, these may include the following [25]:

i. Bribery and Corruption as well as Mismanagement by officials of the power sector.
ii. Vandalization of oil and gas pipe lines by restive youths in the Niger-delta area.
iii. Poor water management culture in Nigeria is also another major factor affecting water level at the hydro generating stations.
iv. The kidnapping activities particularly of foreign and indigenous professionals who are saddled with the responsibility of manning oil and gas facilities in Nigeria which consequently resulted into abandonment of oil and gas exploration.
v. Decline in annual rainfall due to global warming leading to sharp decrease in water levels at hydro generating stations.
vi. Excessive gas flaring in which the government has failed to decisively take action by engaging renowned oil multinationals to utilize fully the gas being flared.

In recent years, there seems to be a better appreciation of the gravity of the infrastructure problem as apparent in various policy initiatives. This combined with the severity of the service failures made possible wide public acceptability and political feasibility of electricity market liberalization. And according to [24] the developments facilitated the passage of the comprehensive Electric Power Sector Reform Act (EPSRA) in 2005. EPSRA embodies radical reforms which if well implemented should produce a robust and competitive electricity industry where unreliable and inadequate service would be the exception rather than the rule [24]. Two significant outcomes of the albeit gradual implementation of the EPSRA, are: the establishment of a regulatory agency, Nigerian Electricity Regulatory Commission, NERC, in 2005; and the unbundling of the industry into six generation, one transmission and eleven distribution companies in 2007 [24]. Despite recent policy initiatives, institutional developments such as Nigeria Electricity Regulatory Commission (NERC), the last minute effort of the former Obasanjo administration to tackle the crisis through the ambitious National Integrated Power Project (NIPP) there still seem to be no clear policy direction [18]. The mid 1970's marked the beginning of energy crises as drastic inflation of petroleum prices occurred and small hydro power (SHP) now became attractive in many developed countries. Revitalization of SHP was set to surge in countries with rich resources, while some developing countries just started to construct to replace diesel generating stations in rural areas to save foreign currency from importing diesel, therefore the installed capacity in many countries rises from few hundred KW to tens or hundreds of MW of electricity [1].

II. LOSSES IN ELECTRICAL POWER SYSTEM

Losses in electrical power system are mainly of two types: these are technical loss and non-technical loss.

Technical Losses: Technical losses could be defined as those which are caused by actions internal to the power system and consist mainly of power loss/dissipation in electrical system components which include the transmission lines, power transformers, distribution networks, measurement systems, etc. Technical losses can easily be controlled and computed as long as the power system quantities consist of defined electrical units [6]. The kind of distortion of electrical load quantities that is caused by NTL could however distort the computations of the technical losses primarily caused by prevailing electrical loads, thereby rendering any result indecisive. A common example of such losses is the power loss caused by resistance of transmission lines.

Non-Technical Losses: Non-technical loss (NTL) can be defined as that which is caused by actions outside to the power system, or are caused by loads and conditions that the technical losses computation failed to take into account [3]. NTL are more difficult to measure because they are frequently not taken into consideration by the system operators thereby having no defined information. The most probable causes of NTL are:

i. Errors in accounting and record keeping that distort technical information (estimated billing)
ii. Non-payment by customers
iii. Electricity theft (by-passing of meters, illegal connections) etc.
iv. Errors in technical loss computations (wrongful assessment of customer load)
v. Lack of taking into cognizance increases in system losses due to equipment deterioration over time, but are usually disregarded in all calculations.

The most prominent forms of NTL are electricity theft and non-payment, which are considered to account for most, if not all, of NTL in electrical power systems. It is estimated that electricity stealing/theft in Nigeria costs billions of naira each year [13] and it is this whoopee sum and with metering experience prompted this work on Electricity Energy theft which translate to non-technical losses (NTL).

III. ANALYSIS OF LOSSES IN POWER SYSTEM

A. Analysis of Technical Losses

Technical losses are those that emanates from inefficiency of equipment or system, the characteristics nature of the equipment, materials that were used in the lines and their sizes. Transformer losses include copper losses due to the core loss and internal impedance of transformer coils. The no-load losses of power transformers have to be considered because they are connected permanently to the power system. No-load losses are a function of the type of core material, frequency, insulation, voltage and lamination. The most predominant no-load losses are the core losses, made up of hysteresis and eddy current losses [5]. Expressed by the equations:

Hysteresis loss, $P_H = KhfB_m$
(1)

Eddy Current Loss, $P_E = K_e f^2 B_m^2$
(2)

Where,
f = frequency,
B_m = flux density of the core material,
K_H, K_e = Hysteresis & Eddy current constant.

B. Analysis of Non-Technical Losses

NTLs, by contrast, relate mainly to power theft in one form or another. They are related to the customer management process and can include a number of means of consciously defrauding the utility concerned. By default, the electrical energy generated should equal the energy registered as consumed. However, in reality, the situation is different because loses occur as an integral result of energy transmission and distribution. The total energy loss within the electrical system generally, is referred to as 'energy losses' and can be related with the following equations:

i. Energy losses

$E_{Loss} = E_{Delivered} - E_{Sold}$
(3)

ii. Revenue loss due to technical losses

$C_{Com\ Loss} = U_{ElectCostXEloss} + M_{Maintenance\ Cost}$
(4)

iii. Non-technical loss

$C_{NTL} = C_{ComLoss} - C_{Technical\ Loss}$
(5)

Where, $U_{Elect\ cost}$ = Unit cost of electricity

The information about the power sources and loads are needed to determine expected losses in the power system using load-flow analysis software. The actual losses are the difference between outgoing energy recorded by the source (e.g., at a substation) and energy consumed by the consumers, which is shown on the bills. The discrepancy between expected losses and actual losses could yield the extent of non-technical losses in that system. Therefore, technical losses would be calculated using the available data flow studies. The various specifications of different parameters of transmission line, transmission line resistance and reactance values will be taken from 11KV transmission lines datasheet [23].

C. Measurement of non-technical losses and its minimization

The best way out into obtaining a fairly accurate value of average load demand is to make use of all available information supplied by the segments of YEDC (Jimeta, Jalingo and Numan) business units which is being used to calculate their monthly electric bills. This calculation requires energy consumption accumulated from the beginning of the billing period and the consumption accumulated up to the end of the billing period. The accumulated consumption at the end of the period is subtracted by the accumulated consumption at the beginning of the period. The result is the total consumption during the time period in kilowatt hours and the portion of the bill for energy consumption is based on this number.

D. Approaches for reduction of non-technical losses

When we talk about T and D losses it also includes the theft of electricity, although it is the part of commercial loss but there is no way to segregate theft from the T and D losses. Worldwide the energy loss (and theft) exceeds the total electricity demand of Germany, UK and France, the third, fourth, and fifth largest economies of the world, it is estimated that utilities of developed countries alone lose 500 million dollars every year by way of T and D losses. The theft of electricity is so rampant. For domestic consumer it may be on account of the small temptation resulting from allurement of the staff of the license or any third party agent but for the industries it is many fold as it also enables them to hide their actual production from the department of exercise, sales, tax etc. who determine the production based on the actual consumption of energy. The meter inspection is the main of NTL detection because the utilities consider electricity theft to the major source of NTL and the majority of electricity theft cases involves meter tampering or meter destruction. The following are the various approaches [4] which must be accomplished in order to reduce the non-technical losses at utility and government level.

E. Contemporary Solutions for Minimizing NTL

Several approaches have been recently proposed and deployed by many distribution companies to eradicate or minimize all NTL related draw backs in electrical power distribution systems. Two most predominant methods have been used by YEDC; namely:

i. Massive installation of electronic energy meters on its high profile customers and
ii. Purchase and implementation of Automated Meter Reading (AMR) infrastructure for remote reading and monitoring of all these high profile consumers.

These are all geared towards the revenue protection of the DISCO, despite their high cost and necessary network infrastructure extensions the methods have proven to be beneficial [20]. But most DISCOs in Nigeria still unfortunately focus on onsite technical inspection of customers, but it has higher operational costs and requires so much of human resources Onsite daily with so much of human errors [17].

IV. SOLUTION METHODOLOGY

Total system losses for a utility system can be calculated directly as the difference between production energy and electric sales. Losses obtained from metering differences are the most definitive method of determining energy losses. Errors are introduced into these values, however, because of meter reading billing cycles, meter placement (high side or low side of the generator transformer, for example), and accounting procedures, particularly for utilities which have other utilities' load within their service territory or which have loads within other utilities service territories. Energy diversion (stolen energy) may also result in the mis-representation of losses calculated from the differences in the meters. Un-metered substation and company use will also be included in the metered difference and must be accounted for in the measured losses. After all non-technical losses are accounted for the remaining losses are the technical losses, those caused by current and voltage in lines and equipment [7]. Even though T and D losses including unaccounted energy are about 30% [10] and there is need to reduce these losses through efficient management and the best operation and maintenance practices of the transmission and distribution.

V. ENERGY AUDITS

Energy audits are a useful tool to provide the information needed to implement energy efficiency measures in a specific environment. The

International Journal of Advances in Engineering and Management (IJAEM)
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literature reviewed supports the idea that there is a direct link between implementing energy audits and achieving tangible energy savings but is less clear about the extent to which energy audits can trigger real and persistent changes in consumer behavior [19].

The application of meters to individual buildings and energy-intensive equipment provides facility managers and operators with real-time information on how much energy has been or is being used. This type of information can be used to assist in optimizing building and equipment operations, in utility procurements, and in building energy budget planning and tracking [5]. It is important to keep in mind that meters are neither an energy efficiency nor energy conservation technology per se; instead, meters and their supporting systems are resources that provide building owners and operators with data that can be used to reduce energy use, reduce energy costs, improve overall building operations and improve equipment operations. This shows how the metered datas used are critical to a successful metering program. All these depend on the type of data collected, and can enable the following practices and functions:

i. Verification of utility bills
ii. Comparison of utility rates
iii. Proper allocation of costs or billing of reimbursable tenants and
iv. Demand response or load shedding when purchasing electricity under time-based rates

[8] Describes an electric meter or energy meter as simply a device which measures the amount of electric energy consumed by an electric powered device in residence business premises or commercial premises. Generally, electric utilities use electric meters installed at customer's premises to measure the electric energy delivered to their customer's premises for billing purposes, these meters are commonly calibrated in kilowatt hour (KWH) plate 5.1 and plate: 5.2

VI. CATEGORY OF METERS COMMONLY USED FOR ELECTRICITY ENERGY MEASUREMENT

The under listed meters are the most available types of energy meter deployed by YEDC to its customers.

i. Electromechanical Energy meters (single and three phases)
ii. Digital Energy meters (single and three phases)
iii. Pre-payment meters (single, three phase and MD)
iv. Maximum Demand Meters(low voltage and high voltage)

Plate 5.1: Three Phase Digital Energy [9]

Plate 5.2: Electromechanical Energy Meter [26]

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The electromechanical meter displays electricity consumption in kWh and records it on a cumulative basis. The customer, residential or commercial, receives an estimated monthly bill for cumulative consumption; this estimate can be adjusted at a later stage once a meter reader has visited the premises or a customer has reported a reading to the supplier. Tariffs are set by the supplier and are based on a unit (kWh) rate. Suppliers may offer a tariff that charges a higher unit rate for consumption over a certain level; however in most cases the tariff rate is independent of time of use. As the meter records consumption cumulatively, there is no record of previous consumption. Certain types of electromechanical meters have multiple mechanical registers that can record cumulative consumption according to different times of the day. Economy meters in the UK provide two different readings: one for day-time and one for night-time usage. Suppliers can apply a different rate to electricity consumption during the night when electricity is not as costly to produce (usually 7 hours from around 1am to 8 am) and customers are given an incentive to shift some consumption from peak to off-peak times. Some economy customers opt for suppliers to control their systems automatically via a radio teleswitch; timing can be varied manually or in some cases remotely using teleswitch. Electric storage and hot water heating, for instance, can be controlled to switch on only once the nighttime rate has been activated [20].

These type of meters operate by continuously measuring the instantaneous voltage (volts) and the current (AMPS) to give the energy used (in Joules, Kilowatt-Hours), note that meters for smaller services such as smaller residential customers can be connected directly in line between source and the use of the Current Transformer (CT) becomes apparent, so that the meter can transform the current in a ratio convenient for measurement of energy, common ratio are 100/5A up to 800/5A on the Low voltage (LV) side, while 25/1A up to 100/1A on the High voltage (HV), these meters therefore fall into two basic categories namely electromechanical type and the electronic type. The cheering news for medium size consumers is that the PPM side of MD is currently being tested by Meter giant Ortech Nigeria Limited which can handle up to 800/5A.

In plate 5.2 above, the amount of energy is represented by one revolution of the disc and is denoted by the symbol KH which is the unit of watt hour per revolution. The value 7.2 is commonly seen and using the value of KH, one can easily determine the power consumption of a customer at any given time by simply timing the disc with a stop watch, in the olden days, this method was used to calculate the power consumption of house-hold appliances by switching the appliances on one after the other.

[15] States from elementary power calculation that

$$P = \frac{3600}{T} \times KH \quad (6)$$

Where

P = Power in watts

T = Time in seconds taken by the disc to complete one revolution and

KH = One revolution of the disc

As an illustration, if KH = 7.2 as stated above one revolution took 15.2 seconds, then the power consumed would be

$$p = \frac{3600 * 7.2}{15.2} = 1705.26 \text{ watts} \quad (7)$$

Plate: 5.3 is a smart pre-payment meter (PPM) installed in Jimeta of YEDC, While plates 5.4 is MD Prepayment Meters.

Plate 2.6:Pre-payment meter [26]

Plate 2.7: MD Prepayment Meter [2]

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The meters above delivers consumption data according to a schedule or on-demand, and accurate meter readings can be obtained from all metering points. In order to ensure accuracy and data quality, metering values are validated before they enter a utility's billing system. In the event of missing values from a particular metering point, the smart metering system automatically re-reads the meter. Smart metering creates added value for the distribution company's balance settlement processes: Distribution network operators can calculate precise consumption, and sales information can be calculated per energy supplier [12]. This means the consumer only pays for energy consumed during the billing period, and estimated invoices and invoice settlements become things of the past. Today, consumption data is automatically transferred from the meter and smart metering system to the utility's billing system, making manual meter readings history. The automated meter reading processes mean a utility can cut down on time-consuming manual work [2].

Plate 5.5: 33KV Metering Point [26]

Plate 5.6: injection sub-station switch yard [26]

Electricity Distribution Companies (DISCOS) provide last line services in the electricity supply value chain. The DISCOS provide the connection between customers and the electricity Network which is taken from the Transmission Company of Nigeria (TCN), hence, are left with contagious last mile problem of the system characterized by high costs and quality of service which is synonymous to what was faced by the erstwhile telecoms industry. DISCOS are responsible for transforming or stepping down electricity from the high voltage of 132 KV at the transmission level, to the lower voltage levels of 33KV/11KV/0.415KV depending on the category of customer, although in some cases some customers are fed directly from the 132kv sub-transmission system like the Savannah Sugar Company in YEDC network. Electricity in most residential homes is supplied at voltage level of 0.415KV. DISCOS are also responsible for the marketing and sale of electricity to customers. This is an extremely important function in the electricity value chain as the DISCOS are the cash boxes of the entire electricity value chain without which all the revenue needed to sustain the electricity industry would be a mirage, hence every single energy should be properly accounted for if the system must survive the prevailing circumstance [22].

Grades of Metering

In Nigeria, there are five main grades of metering namely: Grid Metering, Distribution Sub-Station Metering, Distribution Transformer Metering, Commercial Metering and Domestic Metering.

The grid metering involves the primary meters of the market operator and forms the basis of the monthly bills received by the distribution companies for settlement. The only information available to the DISCOs from these meters are the megawatt hours of energy received and other valuable information such as the profile of how the energy was received, power quality, but other critical events that could assist the DISCOs in future planning or in marking a case for improved service from the system operator are un-available. Luckily however, the Nigeria Grid Metering Code recognizes the DISCOs right to have access to this information hence the need for distribution sub-station metering [2].

Distribution sub-station metering: apart from the supply interfaces of business units most distribution sub-stations in Nigeria does not have

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energy meters and even those that have the meters may be old and not AMR-capable. Plate 6.1 is a pole mounted boundary Meter installed between Jimeta district and Yelwa (Yola–Town district) all of YEDC, while Plate 6.2 is a Panel Metering arrangement where a consumer is metered on high voltage side, in which all cases of the transformer losses are captured.

Plate 6.1 pole mounted boundary Meter [26]

Plate 6.2: Distribution Transformer Metering [26]

Distribution substation metering: The metering of distribution transformers is the most complex of the five levels, this is because:

i. There are a lot of distribution transformers and the entire solution must be simple and cost effective.
ii. The metering system has to be compact, physically unattractive and have the possibility of aligning its colour with the transformer as a camouflage to enhance its security.
iii. The metering has to be very simple to install so as to enhance speed of coverage.
iv. The meter accessories and connections must be protected from rain water, sunlight, fire (which may result from explosions or bush burning) and sometimes vandalization.
v. The meter Current Transformers (CTs) and other accessories must meet all (International Electrical Commission) IEC standards.
vi. The installation should be in such a way that it does not interfere significantly with routine maintenance operations of distribution technicians.
vii. Data collection should be by remote communications technique so as to:
   a) Reduce the cost of data collection activities
   b) Enhance speed and overall efficiency and
   c) Avoid drawing attention to the installation

Commercial and domestic metering: In spite of the considerable achievements of recent times with regards to electricity generation in Nigeria a lot still need to be done in the area of proper and adequate metering of the commercial and residential (domestic) consumers.

Statistical metering: Another important form of metering is the statistical metering which is simply a non-revenue type of metering meant to provide varying degree of insight into power utilization within a network. In its simplest form, a statistical meter can be installed on an 11/0. 415 KV public transformers to check the energy utilized through it and to use this as an audit tool in determining unacceptable level of losses. This same meter can also be used to obtain profiles of loading, voltage quality, frequency variations, harmonic distortions, supply outages, power factor, phase balancing, and in events such as short-circuiting of phases. This array of information in the hands of a good commercial or technical manager can be the ultimate tool that makes his job easy and effective [14]. As an example, the energy value obtained from this meter can form the basis of setting commercial targets for marketers, meter monitoring staff, and their supervisors and the technical information obtained can be indicative of the health of the transformer and can assist the technical manager to respond quickly before irreparable or expensive damages occur.

The principle of statistical metering can be applied at all levels of the supply chain. Starting with the 330/132KV transmission station from where the distribution company receives supply, down to its own 33/11KV distribution sub-stations and finally to the 11/0.415KV distribution transformers within the network, statistical metering can be implemented to provide a complete network overview in terms of energy allocation and supply parameters. If statistical meters were to be installed on the 33KV Incomer and all the 11KV Feeders in a sub-station, as example, it becomes easier to ensure that operators follow management instructions on power allocation. The first step of energy accountability within the local network also begins from here, and it becomes easier to determine revenue-yielding feeders that should be prioritized. Now, imagine the power of all the information highlighted above at the click of a mouse.

It is impractical to expect that the enormous data resident on statistical meters to be retrieved manually, therefore, the Automated Metering Infrastructure (AMI) which is commonly referred to as Automatic Meter Reading (AMR) system becomes an imperative, and the implementation of a statistical metering programme is only value-added as no extra cost will be incurred apart from the metering system [14]. Metering services consist several activities that do not incessantly have to be carried out by a single party [14].

a) Meter provision (Supplying Metering Equipment)
b) Meter operation (Installation, Operation and Maintenance)
c) Meter reading and data processing electricity has a marginal cost of production that fluctuates rapidly due to two of its main characteristics.

All these happen because electricity must be consumed as it is produced; its cost of production is sensitive to the time when it is used. Secondly, it is the only product that is consumed continuously by almost all customers, its real-time cost is determined by retail customers physically taking power from the grid rather than agreeing by contract with the generator in advance. The cost of delivering electricity to the customer also fluctuates rapidly and depends on the amount of electricity all customers are demanding at any given time.

VII. CREDIT ADVANCE PAYMENT FOR METERING IMPLEMENTATION (CAPMI) SCHEME

To overcome the challenge of metering and the failure of the Distribution Companies (DISCOs) to keep to their pledge in their business plan to meter their customers. The NERC yielded to the suggestion from some customers and DISCOs for an arrangement where a customer will advance payment for the purchase and installation of meter, while he recoups his investment over a period of time with interest.

This is so because, by the electricity tariff arrangement, a customer is entitled to a meter without upfront payment. This arrangement is known as Credited Advance Payment for Metering Implementation (CAPMI). The commission described it as a child of necessity to serve as a stop gap for the willing customers who can't wait to escape the prevailing estimated billing regime adopted by DISCOs [16]. Explaining the wisdom behind the CAPMI, the NERC said one of the priorities of the commission is the speedy metering of customers. Numerous customers' complaints indicate a high level of dissatisfaction with the way they are billed by the DISCOs. Currently, no upfront payment for meters is required of customers. The commission considers it expedient to explore either avenues of ensuring that customers are metered to eliminate wildly estimated bills. The scheme provides that these advance payments are subsequently refunded through a rebate on the fixed charge component of their electricity bills (although this is yet to commence in YEDC). The main advantage of this arrangement is the expectation that it will minimize estimation of the customers' tariff payment and enhance revenue collection of the DISCOs [16].

VIII. CONCLUSION

The paper has analyzed the benefits of metering to the electricity supply chain for the sole purpose of enhancing service delivery to ascertain any net improvement in revenue collection when compared with delivered energy and actual revenue collected for such within a sampled billing period. Suggestion was made on how to minimize non-technical losses to enhance reliable and sufficient electrical power supply because non-technical loss investigation is long overdue for YEDC. The total electrical energy supplied to all of the selected districts for the period being investigated was collected from the authorities of YEDC and the measuring tools used for the physical measurement of electrical quantities are: The Clamp-On meter and the 100/5A Check meter. Houses were selected at random as sample comparism for metered and unmetered consumers; the metered houses were installed with a check meter to ascertain the accuracy of the existing meter in the customer premises, whereas the unmetered customers were monitored with clamp on meter. The overall findings indicate that indeed non-technical loss is very significant in YEDC and that massive deployment of meters, proper billing system and installation of an effective online monitoring

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 8, pp: 656-666 www.ijaem.net ISSN: 2395-5252

system is very crucial and urgent for the selected segments of the zone.

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