

# Inadequate and Poor Electricity Metering Affect Energy Efficiency End-user Behaviour in Nigeria

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**Abstract—** Electricity metering has been identified as one of technologies where end-use energy efficiency can particularly be encouraged in households through its impact on tenants' behaviour. Inadequate metering is one of the immediate obstacles facing Nigeria power industry. In other to further increase energy efficiency capacity considering the economic and environmental benefits, this review takes a look at the electricity metering situation and how it affect energy efficient end-user behaviour in Nigeria. Energy efficient end-user behaviour is a critical parameter to the success of each national energy policy and programs. Metering gives consumers' clear and comprehensive information about their energy consumption and, with providing better information, can help consumers to become more energy efficient. In other to encourage efficient use of electricity in Nigeria, the Distribution Companies (DISCOs) should adopt a firm policy for 100% metering.

**Keywords—** Electricity, Metering, Energy Efficiency, End-users Behaviour, DISCOs, Nigeria

## I. INTRODUCTION

In a developing country like Nigeria where electricity is in short supply, efficient use of energy will enhance consumption of electricity. This would include education of the public on energy conservation and efficiency. It also involves a review and upgrade of energy efficient standards. By this we mean that buildings and appliances used in the country should have been of high standards such that it consumes the lowest quantity of energy possible. Energy efficiency products essentially help to

do more work with less energy. For instance, to light a room with an incandescent light bulb of 60 W for one hour requires 60 W/h (that is 60 watts per hour). A compact fluorescent light bulb would provide the same or better light at 11 W and only use 11 W/h. This means that 49 W (82% of energy) is saved for each hour the light is turned on [1]. The use of incandescent bulbs for lighting is energy intensive. Only about 5% of total energy used by an incandescent bulb is converted to light energy, the remaining 95% is converted to heat energy [2].

As we can see so far, there are two important ways we can approach the efficient use of energy. The first one is the technological approach while the second is the behavioral approach. For the technological approach, we need to change the type of technology we use to a more efficient one. A good example is the one we cited above on the light bulbs; replacing incandescent bulbs with energy efficiency bulbs. The behavioral approach entails changing the ways we do things. An example is switching off appliances when not in use [1].

There is general lack of awareness of energy efficiency benefits among Nigeria masses. The poor and inadequate electricity metering system in Nigeria has not helped the consumers in developing the behaviour of using electricity efficiently. This is because most Nigeria receives estimated bill from DISCOs every month, whether they used electricity efficiently or not they will receive the same bill. This has discourage the few that is aware of the benefits of energy efficiency from developing the behaviour of using electricity efficiently because of the inability of monitoring the energy use due to lack of meter.

Under current European Union (EU) legislation, final consumers

should already be frequently informed about their energy consumption at the time of use. EU member states are also obliged to roll out smart electricity meters for at least 80% of their final consumers by 2020 and to achieve full coverage by 2022 [3]. According to [4] Smart Grid is supposed to help deal simultaneously with a range of issues: grid management optimisation, peak-hours electricity consumption reduction, wider usage of renewable energy sources for the electricity production and consequently Green House Gas (GHG) emissions reduction. However, smart grid concept cannot be taken for granted as the universal solution for all problems. It is a powerful framework which can assure that the full potential of concrete energy efficiency measures is systematically utilised

and verified. Smart Metering is significant part of this powerful framework but unfortunately most of the countries still have not activated this potential yet.

The EU countries have started rolling out smart electricity meters in order to achieve full coverage by 2022, while greater percentage of metered consumers in Nigeria still make use of inefficient meters like Electromechanical watt-hour meter. Electromechanical meters are obsolete in today's electronic, highly computerized environment. The digital meter is preferred for measuring electricity production and distribution, and in the customer service and payment processing arena. The historical metering and new trends is shown in table 1:

TABLE 1  
Historical Metering and New Trends [5]

Expectation	Electromechanical	Electronic	Prepayment	Future Smart Metering with Prepayment and remote disconnect/reconnect
Adherence To Minimum Standards	Yes	Yes	Yes	Yes
Accuracy Of Measurement	Within a range	Yes	Yes	Yes
Adequate Communications Network	No	No	No	Yes
Cost Effectiveness	Affordable without budget function	Affordable without budget function	Costly with budget function	High Capital outlay with budget function
Security Of Metering System And Data	Tamper, wrong reading, and bypass	Bypass	Bypass	Highly secure
Adequate Feedback For Parties	No	No	No for keypad but yes for smart card through manual means	Yes
Total Energy Accountability	No	No	No	Yes
Owner And User Responsibilities	Yes	Yes	Yes	Yes

Smart Metering is a technology encouraging end-use energy efficiency. Smart Meters can give consumers clear and comprehensive information about their energy consumption and, giving them better information, can help consumers to become more energy efficient. However, installing Smart Meter without consumer participation and additional services will, by itself, do nothing to save energy since the meter is simply an “enabler”.

Energy savings will be achieved only if the installation of meters is connected with the comprehensive informational campaign which will help consumers to actually understand their energy consumption and incite them toward sustainable behavioural changes [6].

## II. A BRIEF BACKGROUND OF METERING OF ELECTRICITY IN NIGERIA

The history of electricity metering in Nigeria is directly linked with the history of electricity development in Nigeria. The production and delivery of electricity to consumers on a commercial basis began in the country in 1896. Electricity generation and distribution were largely decentralized until 1951 when the Electricity Corporation of Nigeria (ECN) was established as a central body responsible for electricity supply. The first 132KV line linking Lagos to Ibadan Power station was constructed in 1962. In 1962, the Niger Dams Authority (NDA) was established with a mandate to develop hydro power stations. The ECN and NDA were later merged in 1972 to form the National Electric Power Authority (NEPA) by virtue of the NEPA Act [7]. The National Electric Power Authority operated a vertical integrated structure in carrying out its primary functions of generation, transmission, distribution and marketing of electricity in Nigeria. This state of affairs persisted until 2006 when NEPA was unbundled into 18 successor companies in line with the power sector reform programme of the Federal Government of Nigeria [8]. The procurement of meters for all the aspects of the electricity business in Nigeria was centrally coordinated at the Head Office of NEPA where requests were received and treated from a central pool. Metering instruments including Grid Meters for Generation/Transmission, Transmission/Distribution and Distribution interconnecting points were procured and deployed to all the stations centrally. The distribution companies were saddled with the responsibility of allocating and installing the meters at the premises of customers. A Grid Metering group was responsible for installation and maintenance of Grid meters. There are three Meter Test Stations located in Lagos, Kaduna and Port Harcourt. These stations are primarily responsible for calibration and repair of all the types of meters in the network. They also certify the integrity of the meters before deployment and installation. It should however be noted that with the implementation of Power Sector Reform Act 2005 and the unbundling of PHCN, the processes involved in procurement and deployment of metering systems are also being restructured.

Some form of autonomy has been achieved as the DISCOs can now procure and install meters independently. In view of the centralized administration of metering in PHCN, and the attendant inefficiencies in delivering meters to customers, there is a great deal of dissatisfaction among customers across the country on billing and metering generally. Electricity Customers at different fora have complained about exploitation and corrupt tendencies by the distribution companies in their metering, billing and collection of charges. The incidence of estimated billing has become rife and cases of customers who have paid for meters without receiving them after waiting for an unreasonably long period of time on end abound. . This has great adverse effect on the image and public rating of the distribution companies which are variously described as inefficient, negligent, unresponsive, corrupt and lackadaisical. Therefore, there is the need to address issues relating to metering of electricity in order to create an equitable electricity industry where the companies get value for their services and the customers pay only for electricity consumed [9].

## III. METERING SITUATION IN NIGERIA

Inadequate metering is one of the immediate obstacles facing Nigeria power industry. To a large extent the gap in the grid metering is being met but there however remains a huge gap in the level of metering of retail customers. The lack of adequate retail meters is contributing to the high level of commercial losses as customers are disenchanted in paying bills that they often times dispute as not being accurate [10].

Currently, DISCOs uses two methods of metering system; the post-paid (analog) billing system and digital pre-paid meter. The labour-intensive post-paid system which involves reading meters physically by the DISCOs employees and paying for already consumed electricity. Often times, this is the method that accounts for major non-technical or vampire losses due to corrupt practices such as bribing of officials who waive bills for customers and bypassing of wires by customers themselves. Consumers who claim they are overcharged due to estimation of bills would often want to pay back by passing or not paying bills

at all. The pre-paid meters reduce the issue of non-technical losses as it helps to prevent overcharging on the consumers. Although, only a small percentage of consumers have pre-paid meters and this can be said to be one of the contributing factor to non-technical losses incurred by DISCOs such as; giving exorbitant estimated bills not in line with meter reading. Exorbitant monthly electricity bills which occur as a result of

meter estimation rather than correct meter reading and calculation based on uninterrupted electricity use thereby charging for power not used can cause consumers not to comply with monthly meter bills and avoid paying electricity bills [11]. The metering coverage in the Nigerian electricity supply is shown in table 2:

TABLE 2  
Metering Coverage in the Nigerian Electricity Supply (NESI) [9]

S/N	Distribution Company	Metering Coverage in the Nigerian Electricity Supply Industry (NESI)								
		Customer Number	Metered Customers	Unmetered Customers	Electro-mechanical Metered	Electronic Metered	Prepaid Metered	Functional Meters	Faulty Meters	Customers on Estimated Billing
1	Abuja	519,486	249,710	269,775	92,181	0	157,529	249,608	21,734	21,734
2	Benin	640,802	493,027	212,131	249,811	44,566	198,650	374,563	73,672	77,127
3	Eko	319,619	153,983	165,228	65,109	7,156	81,718	165,228	101,558	21,427
4	Enugu	578,565	386,505	203,609	285,616	4,944	95,945	385,727	188,251	206,373
5	Ibadan	1,007,643	565,194	442,349	443,268	93,727	28,199	336,465	100,600	188,961
6	Ikeja	583,057	362,066	220,991	285,004	5,037	72,025	298,419	71,330	80,991
7	Jos	328,854	197,762	130,585	146,267	14,318	37,177	146,585	51,177	181,762
8	Koduna	302,281	105,747	196,534	53,283	10,745	41,719	96,692	9,055	9,055
9	Kano	343,947	117,861	226,086	50,908	23,455	43,498	102,328	15,137	15,135
10	Port Harcourt	372,230	175,908	196,322	121,848	9,571	44,489	150,036	25,877	62,554
11	Tola	176,495	85,938	91,435	55,702	1,860	28,376	42,582	43,356	43,356
<b>Total</b>		<b>5,172,979</b>	<b>2,893,701</b>	<b>2,355,045</b>	<b>1,848,997</b>	<b>215,379</b>	<b>829,325</b>	<b>2,348,233</b>	<b>701,747</b>	<b>908,475</b>
<b>% of Metered Customers</b>			<b>55.94%</b>	<b>45.53%</b>	<b>35.74%</b>	<b>4.16%</b>	<b>16.03%</b>	<b>45.39%</b>	<b>13.57%</b>	

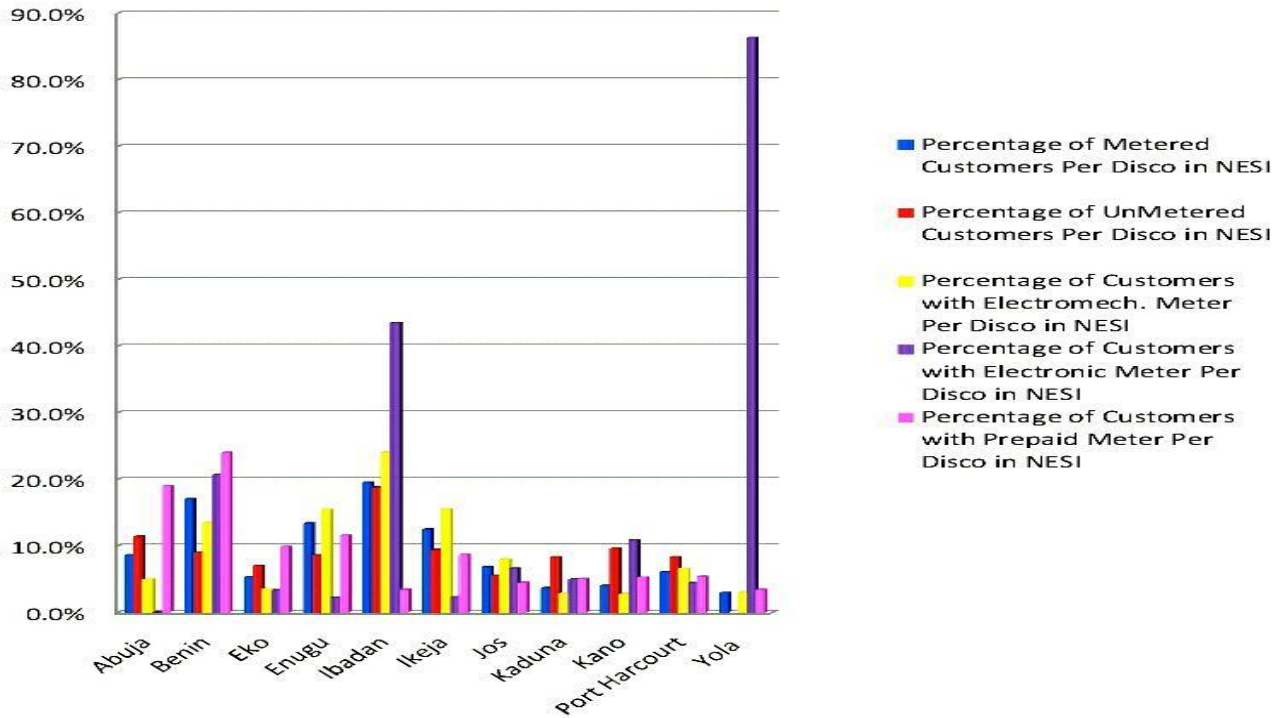


Fig. 1 Summary of Metering in NESI [9].

The [9] revealed that the total number of customers captured in the records of operators of the Nigerian Electricity Supply Industry is 5,172,979. This represents 18.65% of Nigeria’s total households put at 28,900,492 as provided by records from the National Bureau of Statistics in 2006. This record however, does not include those enjoying electricity illegally who are not registered by the Discos, known as ‘illegal consumers’. The number of illegal consumers according to all the Discos is quite high and very difficult to capture, however they claim to be doing their best and that as soon as they discover any illegal consumer they are immediately captured in their billing records. The data provided also indicated that out of the number of customers registered, 2,893,701 or 55.94% were metered, while 2,355,045 or 45.53% were unmetered. The Committee however discovered that out of the total number of customers metered about 701,385 or 22% of the meters were faulty. The implication of the analysis above is that at present a total of 2,956,069 or 54.83% of all the customers registered are not metered at all or have no functional meters. On the average therefore only about 2,434,541 or a minute 8.42% of the total

households in Nigeria are currently being billed correctly by all the DISCOs if a household is used as our metering index. The remaining registered customers are therefore at the mercy of estimated billing. This development has created a wide gap in effective billing which calls for emergency response.

#### IV. LACK OF INTEREST IN AND AWARENESS OF ENERGY EFFICIENT TECHNOLOGY

Lack of sufficient information of energy end-use by the consumers is one major reason why there is under-investment in cost-effective energy efficient options and lack of interest in efficient use of electricity in Nigeria. Usually customers remain relatively ignorant to the type and choice of appliance that is energy efficient.

There is a general lack of awareness of energy conservation benefits, potential, practices and technologies among the Nigerian masses that are the target market. According to a study carried out on the diffusion of energy efficient products,



generally, consumers show minimal interest in the energy efficient criteria. This situation is termed 'the energy conservation paradox' and implies that consumers under-invest in energy efficient technology, relative to the economic minimum [12]. This can be attributed to poor and inefficient electricity metering system in Nigeria, because of the inability of consumers monitoring the energy end-use.

In making decisions to purchase appliances, global environmental concerns are rarely taken into account by both domestic and industrial/commercial consumers and this being the case, appliances manufacturers have no inducement to improve the energy efficiency in their products, as this is not perceived to induce a sale [13]. Arguably, it is the lack of knowledge about the Technology and its economic or technical benefits that brings about this situation. This position is exacerbated by Nigeria's low purchasing power which causes economic reliance on cheaper, imported second-hand goods, particularly electrical appliances made from obsolete and inefficient technology. This is also the case for a lot of the technology used in Nigeria, which owing to the lack of capital and a desire to minimise investment costs, tends to be based on cheaper, out-dated technology [14].

## V. ENERGY EFFICIENCY AND BENEFITS OF SMART METERING

### *A. Important of Energy Efficiency*

Energy efficiency has become the key driver of sustainable development in many economies in the world. If we use energy efficiently, it will lead to the saving of personal income; families will not have to spend so much money paying for energy. It will help to reduce the building of more power stations, thus the money for building power stations will then be spent on other sectors of the economy. More also, more people will have access to energy; if we save energy in one part of the country, the energy saved can be made available in another part. In Nigeria, where the utility companies do not have enough energy to meet the needs of everybody at the same time, energy supply is alternated. With good energy management at the residential,

public and private sector, there will be no need to alternate electricity supply [1]. And also the impact on the environment will be reduced.

### *B. Benefits of Meters to Energy Consumers*

The benefits are many. The information that a smart meter makes available will allow a customer to take control of his or her energy budget. It will enable decisions to be made that conserve energy and natural resources, reducing the impact on the environment. The obvious benefit of these meters to energy consumers is fair billing. Energy consumers in Nigeria have always complained about the unfair billing method used by Distribution Companies. DISCOs in most part used estimated billing; this although reduces the workload on DISCOs but produces very unrealistic bills for consumers. Customers were sent bills by the DISCOs, without any regard for actual energy consumed. However, with these new energy prepayment meters energy consumers in Nigeria will only pay for actual energy consumed. The other benefit of this meter to the consumer is control. Energy consumers can now control their energy consumption. If you find yourself using more energy, you can decide on what to cutout in order to reduce your energy consumption.

## VI. CONCLUSION

Energy efficient end-user behaviour is a critical parameter to the success of each national energy policy and programs. DISCOs urgently need to address serious shortcomings in retail metering that are hampering the company's ability to collect its revenues and energy efficient end-user behaviour. DISCOs should issue a policy document stating the following: 100% of connections are to be metered; all connections without meters will be provided with meters by a set date; all defective meters will be replaced within a set timeframe; and no more new connections will be given without meters after a set date. DISCOs should also begin to work toward upgrading their meters to smart meters. One of the biggest advantages of Smart Metering implementation for household consumers is accurate and informative billing. The information that a smart meter makes available will help

consumers to understand their energy consumption. Only after understanding its energy consumption it can be expected that the consumer will be capable to systematically decrease its energy demand, save money and as a result reduce the impact on the environment.

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