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Metering and Investment in Nigerian Electricity Distribution Market

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***Abstract*— The National Electricity Regulatory Commission adopted different incentive mechanisms to ensure that the electricity distribution firms undertake sufficient investments to improve the quality of service to public. Hence, the study examined the metering and investments undertaken by the eleven (11) DisCos in Nigeria from 2014 to 2015 after the successful unbundling of the industry. Analysis of variance was employed to provide a statistical inference by taking into account the nature of physical investments by the DisCos. The results showed that there in an increase in the investment, but the increase was insignificant and implies low metering investments in the study areas. The results confirm that DisCos have partly responded to the investment and metering in their franchise areas, but it is inadequate to drive the industry. It is therefore recommended that the NERC should create more incentive and investment credit guarantee schemes to encourage more investment and metering in the Nigerian electricity supply industry**

***Index Terms*— DisCos, Energy, Electricity Market, investment , Metering.**

I. INTRODUCTION

Electricity supply infrastructure investment is capital intensive and characterize by economics of scale and indivisibility that gives rise natural monopoly. therefore, subject to economic regulation. In recent years, the need for network expansion, integration of renewable energy resources, demand side participation, and adoption of new technologies such as deployment of smart meter has necessitated significant amount of investments in the grid (Iwayemi, 2008). This has placed the issue of investment at the core of recent energy policies and regulations in the power sector.

It has always been the basic aim of energy policies to ensure sufficient investments in maintaining and modernising the grid and at the same time avoiding inefficiency in capital expenditures in order to protect end-users against high electricity prices. This is because nearly one-third of final electricity prices are related to distribution and transmission network charges (Pollitt & Bialek, 2008).

Electricity distribution companies are responsible to delivering energy to the end users and hence, they are always required to have a reliable and available network. These obligations are usually stated in the regulation and standard of practice for the power sector. The EPSR Act, in 2005 has that the distribution companies are obliged to support and facilitate a market- oriented electricity sector through developing and maintaining an economically and technically efficient distribution system (Shaw et al., 2010).

The companies are also required to comply with additional standards such as those related to the metering, security of supply, safety and customer services. These challenges necessitate an investment plan to helps network companies to achieve their performance targets and at the same time ensure all statutory and legal responsibilities are met in the country. Metering and investment are critically important to efficient electricity supply and sustainability of the electricity industry.

The Nigerian electricity industry supply chain, especially at the distribution level, is characterized by poor metering: majority of the customers are on post-paid meters and the rest are unmetered.. The problem of billing out-of-the meter by the Electricity Distribution Companies (DisCos) has resulted to low returned in investment. Customers are unwilling to pay estimated bills associated with unmetered customers. It is assumed that estimated bills by Discos have the tendency to overcharge electricity users and possibly provoke payment apathy. The situation appears not to have changed and deadline by the Nigerian Electricity Regulatory Commission (NERC) to Discos to drastically reduce the metering gap in the electricity distribution in the Nigerian electricity market has elapsed. Thus, the study, therefore aims at evaluating the extent of compliance of the metering and investments directive by the Electricity Distribution Companies (DisCos) in Nigerian electricity market.

The study It will give an insight to the NERC on how the DisCos s have complied with mandate of metering their customers and promoting efficiency in the Nigerian electricity market. The remaining parts of the study is structured into four sections as follows: Section two (2) is the Literature review Section three (3) concentrates on the research method. Section four (4) presents the empirical results and discussion of findings, while section five (5) is devoted to the summary and conclusion from the study.

II. LITERATURE REVIEW

Electricity Distribution Companies (Discos) provide the last services in the electricity supply-value chain. Discos provide the connection between customers and the electricity grid and as such, are charged with high costs and quality of service. Discos are responsible for transforming or stepping down electricity from the high voltage of 333kV/132 kV at the transmission level, to the lower voltage levels of 33kV/11kV/0.415kV depending on the category of customer. Electricity in most residential homes is supplied at voltage level of 0.415kV. Discos are also responsible for the

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marketing and sale of electricity to customers. This is an extremely important function in the electricity value chain as Discos are the cash boxes of the entire electricity value chain. All the revenue needed to sustain the electricity industry is earned through the distribution sector.

Nigerian Discos and their Franchise Areas

There are eleven successor Discos in Nigeria arising from the unbundling of the Power Holding Company of Nigeria (PHCN). The Discos and their franchise areas are listed below

. **Table 1: DisCos and Area of Franchis in Nigeria**

Successor Disco	Franchise Areas
Abuja Disco	FCT, Niger, Nassarawa, Kogi
Benin Disco	Edo, Delta, Ekiti, Ondo
Enugu Disco	Imo, Anambra, Ebonyi, Abia, Enugu
Eko Diso	Lagos State (Victoria Island, Lekki, Lagos Island, Apapa, Epe, Ikoyi, etc)
Port Harcourt Disco	Rivers, Bayelsa, Cross Rivers, Akwa Ibom
Ibadan Disco	Oyo, Ogun, Osun, Kwara
Ikeja Disco	Lagos State (Ikeja, Surulere, Ikorodu, etc)
Jos Disco	Plateau, Bauchi, Benue, Gombe
Kano Disco	Kano, Jigawa and Katsina
Kaduna Disco	Kaduna, Sokoto, Kebbi and Zamfara
Yola Disco	Adamawa, Borno, Taraba and Yobe

A. Investment in Electricity Distribution Networks

Electricity distribution companies are responsible to deliver energy to the electricity users and hence, they are required to have a reliable and available network at all time. DISCOs are also required to comply with the stipulated standards by the Energy Reform Act, such as those related to the metering, security of supply, safety and customer services. These challenges necessitate an investment plan that helps distribution companies to achieve their performance targets and at the same time ensure all statutory and legal responsibilities are met.

There are several technical and non-technical factors that can potentially drive investment in distribution network companies. The number of connected consumers and distribution of load, in a specific region, can change and hence require network reinforcement (Blokhuis et al., 2011). Furthermore, the distribution companies can identify development of new residential or commercial sites, within their franchise, and forecast future demand by taking into account the general macroeconomic and market conditions.

External factors can also necessitate network investment because they affect the operation of gird. For example, extreme weather conditions or proximity of distribution lines to trees increase the likelihood of power disruption (e.g., falling tree in the storm). In these instances, investment is necessary to protect the overhead lines against the risk posed by extreme events. The distribution companies are also required to invest in order to improve safety of grid. This, for example, includes horizontal and vertical clearance of overhead lines in accordance with national and international electricity standards and also protection of the equipment from theft and vandalism. This is because the increase in price of metals, in recent years, has made the distribution substations attractive targets for metalwork larceny.

Another important driver of investment, in electricity distribution companies, is network energy losses. Around 35% to 40% of electrical energy is lost in distribution system which apart from the issue of energy inefficiency it accounts for around 95% of operational CO2 emission of distribution network companies (Shaw et al., 2010 and WB; 2014).

The investment drivers in distribution network companies are not confined to technical problems. Non-technical factors can also potentially lead to capital investment. For example, network companies may need to invest in costly underground cables in order to avoid disturbing natural beauty areas or to reduce public opposition with respect to infrastructure development at local communities' proximity (Steinbach, 2013).

B. The Multi-Year Tariff Order (MYTO)

Cost recovery simply means recouping what was invested in providing services. Cost recovery is closely related to tariff. Tariffs mean payments made by beneficiaries of the service. They are streams of revenue from the users that would enable investment cost to be recovered (Mannapbekov, 2011).

Tariff in the power sector is defined according to Kaitafi (2011) as the aggregate price paid by the final consumer of electricity. It is through this that the provider of electricity whether public or private investor will be able to recover costs of energy consumed. Obviously, the public sector finances invested in electricity supply are provided from tax payer's money and other sources of Government revenue. To ensure continued supply of the service and long-term sustainability, there is the need to recover all costs associated with the power service (IRC, 2013). Sustainability according to (IRC, 2013) connotes that the power sector is able to deliver appropriate level of service in terms of quality, quantity, convenience and continuity. Cost recovery becomes imperative now that the Federal Government has handed over the power sector to private operators.

Costs expected to be recovered are electricity generation cost, transmission and distribution costs and they are capital intensive. The costs actually involved in service delivery are: the capital costs, operational and maintenance costs, and the connection costs. Capital cost is the infrastructural cost; for example, the cost of land and building. Operation and Maintenance (O&M) costs are costs involved in production and distribution of services in addition to cost of maintaining the system. Connection costs are costs involved in connecting the user to the system (ADB, 2008). The totality of these costs is recoverable from consumer tariffs and or subsidies. However, Mannapbekov (2011), Kaitafi (2011), Villareal et al (2012), stated that the introduction of MYTO was crucial to resuscitating the declining revenue generation in the industry.

On the matters of electricity, many scholars such as Megginson et al (1999),(Poole 1996), Mankiv (2001), De Sonto (1996)Medema (1999) Esterly (2001) Cook et al

(2003) have all tried to look at generally privatization of the power sector. They all identified the failure of the power sector to function under the government as the main reasons to the transfer of control to the private sector.

Also, Jerome (2008), Zayyad (2007), Izibili, et al (2007) Jerome (2003)[20] were all concerned with the pre-privatization period of the power sector and the all corroborated that financial burden of public enterprise to the government are the reasons behind the privatization of the power sector.

Researchers have carried out various studies on the reform of electricity in Nigeria. For instance, Adoghe, Odigwe and Igbinovia (2009) examined the "Effects of Power Sector Reform on Electricity Supply Reliability and Stability in Nigeria". Abiola and Adebayo (2012) researched on "Towards a Public Private Partnership in the Nigerian Power Sector: Challenges and Prospects" but none of this was on metering and investments in Nigeria. Thus, the study seeks to contribute to the literature by examining the nature of metering and investment by Discos.

III. RESEARCH METHODOLOGY

This section presents the method employed in the collection and analysis of data.

A. Data Type

The data for the study is a secondary data on the physical investments and metering of the eleven Discos from 2014 to 2015. These data are sourced from the National electricity regulatory Commission (NERC).

B. Population of the Study

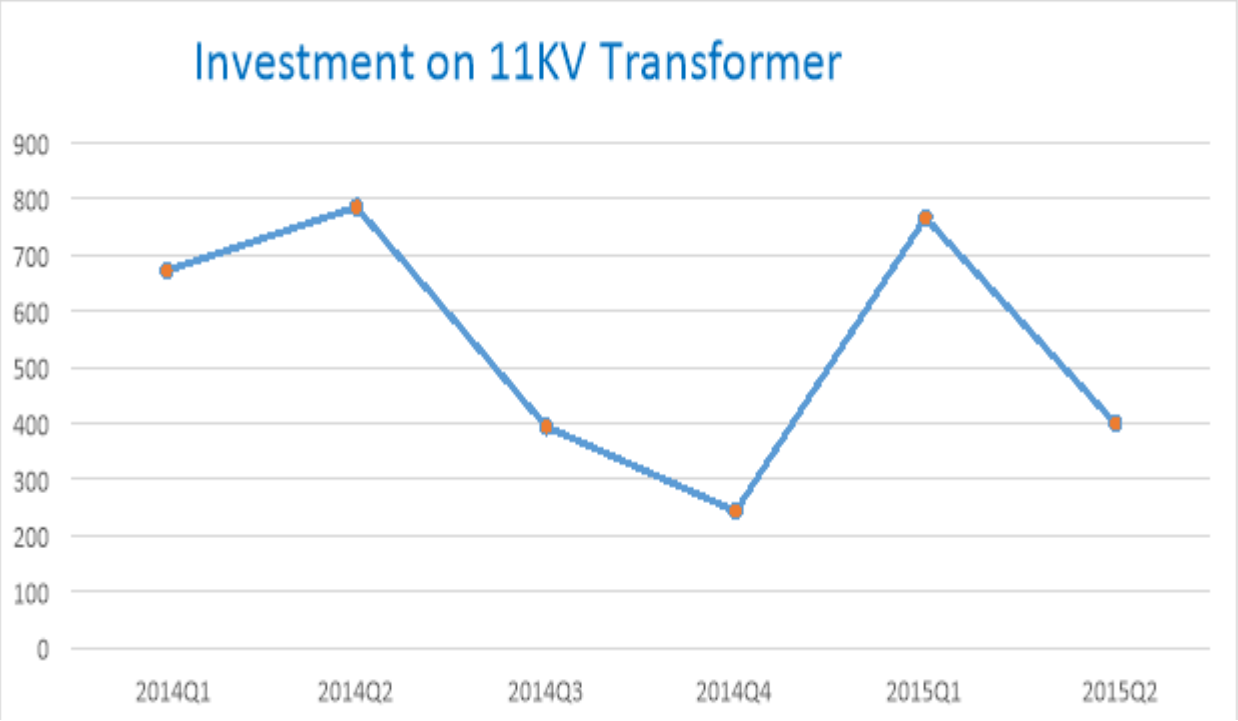
The population of the study is the eleven (11) Discos in Nigeria.

C. Method of Data Analysis

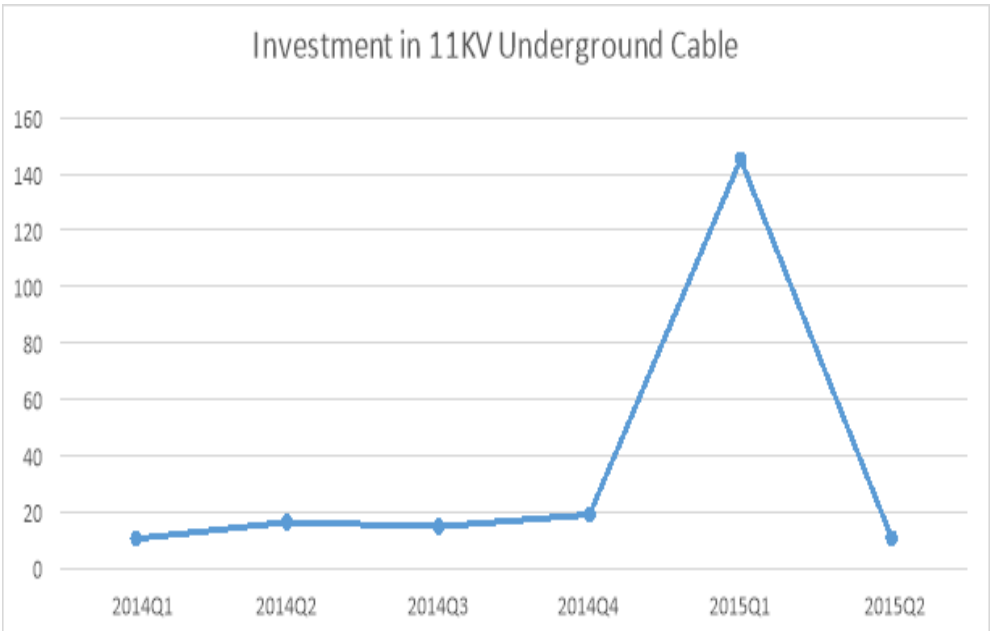
In order to analyze our data in a way that will give a dependable answer to our research questions, we will use techniques of analysis most suitable for this study. Quantitative techniques such as the analysis of variance ANOVA will be used in analyzing data from the field.

IV. EMPIRICAL RESULTS AND DISCUSSION OF FINDINGS

Graphical illustration of the Trend in the Investment Variation

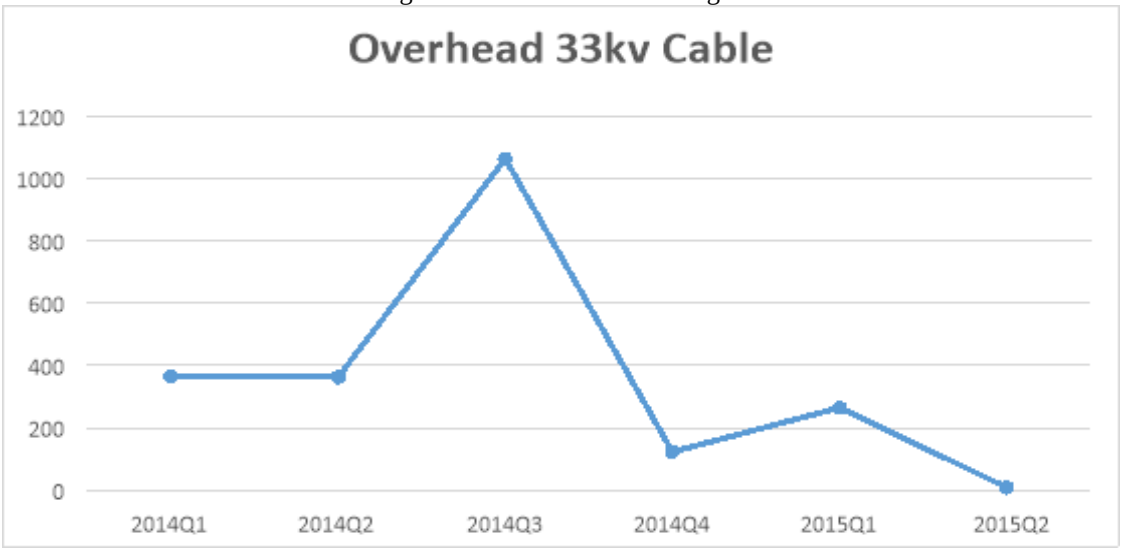


Source: NERC Information



Source: NERC Information

The above charts show an investment trends in 11kva transformers and 11kva underground cable that are usually installed in the residential areas and this is depicted by the rise in their means from 2014 to 2015. There was a slow rise in the trend in both charts in 2014. This could imply that the Discos used the first quarter to take inventory of what they inherited from the PHCN. However, investment was made in the subsequent quarters until the first quarter of 2015 when it began to decline. The increase in transformers installation in the residential areas entail the need for underground cable which are mostly used for transformers installation. Again, the decrease in the overhead cable implies that although the PHCN may have connected all the existing customers over the years, which require less investment in the overhead as more customers have been connected compared with the current connections by the Discos. Yet, the decrease in the connection appears insignificant as the probability value is 0.26 at 5%. Therefore, we are justified to accept the null hypothesis that state no statistically variations in investments and metering in the residential areas.



Source: NERC Information

The chart showed a slow fall and rise in the underground cable investment in the industrial areas. It started rising exactly when the investment on overhead cables got to its higestt level. The rise in 3rd quarter of 2014 showed the need to address the problem of transformers installation and maintenance which requires mostly underground cable. To further justify it, the quarter was the time when the investment on 33kva transformers started rising as shown in the 33kva transfomer graphy below. However, this could explain the fall in the mean of metering from 2014 to 2015 in the industral areas as no significant increase in metering was made rather than intensive maintenance on the already existing transformers and meters. Although, the might be an increase in the investment on metering and transformers but the investment is not statistically significant as shown in the ANOVA result.The chart above showed the trend for 33kv underground cable installation. The trend showed an upward rise in the 2nd quarter of 2014 to 3rd quarter before a steep decline in the investment on overhead cable investment. The possible explanation to this could be that at the 2nd quarter of takeover, there was need for Discos to effectively connect and meter all the maximum demand customers. The target was

achieved within the next (3rd) quarter and it started declining until its lowest point in the second quarter of 2015. This may be the relative security and reliability in supply that the Discos are beginning to experience in the recent years.

Table 2: Metering and Investment in Residential Area

Investment in Residential Areas				Metered Residential Customers		
Investments	**Mean investment 2014**	**Mean investment 2015**	**F-stat**	**Mean metering 2014**	**Mean metering 2015**	**F-stat**
11KV Transformer	57.91	106.00	0.11 [0.18]	170896.5	294353.1	0.15 [0.86]
Underground Cable 11KV(KM)	5.50	14.17	0.50 [0.49]			
Overhead Cable 11KV(KM)	54.95	33.65	1.35 [0.26]			

The p-values are in enclosed bracket
NB: * shows significance variation in investment

The results above showed there is no significant variations among the selected variables used as proxies for physical investments by the electricity distribution companies in the residential areas as the 11kv transformers and cables are mostly used in the residents and small-scale business by the Discos. This is because the probability values for 11Kv transformers and underground and overhead 11Kv cable measured in Kilometers are statistically insignificant (0.18, 0.49, 0.26) at 5% level respectively. Although the investments in the selected variables may have shown an upward movement or trend in the investment from 2014 to 2015 but the variations in investment are not statistically significant. Also, the result showed that variations in metering among residential customers are statistically insignificant as the probability value (p-value, 0.86) at 0.05% interval. Although the mean variations could have shown an increment in metering from 2014 t0 2015(i.e., 170896.5 to 294353.1) but the variation is insignificant between the two (2) periods.

Table 3: Metering and Investment in Industrial Area

Investment on Industrial Areas				Metering in Industrial Customers		
Investments	**Mean investment 2014**	**Mean investment 2015**	**F-stat**	**Mean metering 2014**	**Mean metering 2015**	**F-stat**
33KV Transformer	3.07	2.34	0.24 [0.62]	1258.06	2166.3	0.15 [0.86]
Underground Cable 33KV(KM)	174.10	39.45	2.36 [0.14]			
Overhead Cable 33KV(KM)	136.55	115.64	1.98 [0.74]			

NB: * shows significance variation in investment

The above table showed the analysis of variance ANOVA results on metering and investment in the industrial areas by the eleven Electricity Distribution Companies in Nigeria. The result show that there is no statistically variation in the mean of the metered industrial customers (0.86) at 5% interval. Furthermore, the probability values of 33kva transformers and cables commonly used in the industrial related areas are statistically insignificant (0.62, 0.14. 0.74) at 95% confidence interval respectively. It showed that the variation as seen in the result from 2014 to 2015 is insignificant. Thus, we are justified to accept the null hypothesis that state there is

no statistically variation on metering and investment.

V. Conclusion

From the discussion of results above, it showed that investment and metering are influenced by the number of new and existing customers within the areas covered by the regional Discos. As such, low metering of the customers which is the vehicle designed by the industry for investment recovery will mean low investment as shown in the analysis. The low investments on the selected variables i.e., 33kv and 11kv of transformers, 33kv and 11kv of underground and overhead cables in their means, showed that investments made by Discos since the unbundling are not significant to address the issue of power supply in Nigeria. Put differently, the inadequate investment could be as result of low return on investment by not metering all their customers leading to asymmetric billing associated with unwillingness to pay by the electricity consumers. This will mitigate investment and rather increase ATC and C losses as result of asymmetric bills. Asymmetric billing is a huge problem to the industry and the regulator because there is no transparency in the estimation and unmetered customers appeared to be unwilling in making payments since they cannot justify if the bill is commensurate to the service rendered. However, tariff is structured to be cost-reflective through which the Discos recoup their investments but when there is unwillingness by unmetered customers to pay, this could alter the investment plan or trend. Therefore, there is need to meter electricity users to enhance investment and mitigate ATC and C losses in the industry.

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