Effective Cost Management Model in a Controlled Electricity Market: A Case Study Eastern Part of Nigeria

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***Abstract*— Constructing distribution substations is capital intensive and hence is the best practice in order to obtain optimum profit. Nevertheless, most power distribution companies in Eastern part of Nigeria operate within the substations with equipment and materials that cannot restrict the targeted projected lifespan of the equipment. This study however investigates critically the actual cost of building a typical substation using Eastern part of Nigeria as a case study. The substations consist of New Haven, Abakaliki, Nkalagu, Onitsha, GCM, Awka, Agu Awka, Oji, etc. To determine the cost effective management of these substations, so many questions were raised and analysed in SPSS environment., Z-test was also carried out using Pearson's approach and the result gave no significant difference since the calculated z-values of 0.52 and 1.07 were less than the critical value of 1.96, hence two formulated hypotheses were found satisfactory**

***Index Terms*— Effective cost management, Distribution substation, formulated hypotheses, power distribution, sources of power generation**

I. INTRODUCTION

Electricity is produced at 10-25kV voltage levels from various fuel sources, such as coal, oil, natural gas, hydroelectric sources, wind power and nuclear plants. Electricity injected into transmission networks which operate at 230-763kV voltages to allow economical bulk transportation over long distances by reducing conductor heat loss. Individual transmission lines can be taken out of the network in case of contingencies or for maintenances. At the load centers, electricity is transformed down to lower voltage (0.415kV – 11kV) for distribution to end consumers.

Alternating current (AC) systems as opposed to direct current (DC) systems, are adopted predominantly in bulk power system for the flexibility of voltage convention. For decades, the electric power industry had been viewed as a collection of natural monopolies viable for vertical integration operating under government regulations. However, the consumers' pursuit of economic efficiency and the innovations in generation technology combined with the observation of deregulation successes in other traditionally monopolized industries such as telecommunication, natural gas and airline triggered the restructuring of the electric power industry. Competition and the timing of open market platforms occurred. This process is also described as deregulation and reregulation since some aspects of the industry remain regulated. Regardless of how it is labeled, though, electric power systems have been unbundled to horizontally separated segments of generation, transmission, and distribution to facilitate free competition. Market-based mechanisms are expected to drive the system operations through price signals and economic incentives.

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STATEMENT OF PROBLEM

There also exists the problem of uneven tariff across different distribution companies associated cost and cost related activities that needs to be resolved.The aim is to formulate an effective cost management model in a deregulated electricity market using Enugu distribution network as a case study.The specific objective is to determine and address central problem of transmission investment, it's economic efficiency and effects on system reliability.

SIGNIFICANCE OF STUDY

The study of cost management in a deregulated electricity market can be a learning paradigm in schools to enhance the students' knowledge in the study of electricity distribution and pricing. The research could provide useful information on how to sustain stable power supply, help mitigate against job losses in the electricity market industry by reducing huge losses in invested capital.

OVERVIEW OF ELECTRICITY MARKET

The proposed system Simulation framework, combined with the stochastic model, provides a powerful tool for capturing the dynamic market signals and evaluating transmission investments. In the pre-deregulation era of the electric power industry, economies of scale and scope, as well as the desire to avoid duplication of the infrastructure, led to the formation of regulated monopolies. The industry adopted cost of service regulation (COSR) to achieve a pre-approved rate of return. Although this structure vas successful in balancing development of generation and transmission and other operational aspects, COSR incurred retarded innovation, obscure cost-reduction incentives, and improper decision risk allocation. The perceived flaws of the monopoly structure ultimately led regulators to gradually introduce competition to the industry. The enactment of the public utility regulatory policies act in 1978 encouraged non-utility generation owners to supply power to the existing utilities, Alvarado (2003).

The movement toward more competitive wholesale power transactions was accelerated by the Federal energy Regulatory Commission (FERC)'s Energy Policy Act of 1992, which opened the door of the previously monopoly franchised generation market to independent power producers. The FERC'S orders 888 and 889, in 1996 Caramanis et al., (2015), represent another major milestone by requiring non-discriminatory access to the transmission network. The open access to transmission network and the electricity wholesale market regardless of ownership of the generation unit triggered another building boom of power plants. In addition, the frequent price spikes and extreme volatility in late 1990s created profit and risk hedging incentives for independent and utility-associated power marketers to participate in generation development actively.

Transmission Inadequacy

Regulatory changes in the transmission system were accompanied by nationwide demand increases at an annual rate of 2-3% Hogan (2013) and substantial changes in the generation sector. New generation technologies, particularly gas-fired combined-cycle turbines, allowed electricity to he produced in more modular and flexible quantities with higher efficiency. A building boom ensued added over 200GW of new generation between the years of 1999 and 2004 (NERC. 2004). In many cases, these units were located convenient to construction or fuel resource accesses while taking adequate transmission connection capacity for granted. With the building boom reaching its end and the evolution toward competitive markets well advanced, the transmission system is becoming increasingly vital. The importance of its new ole of supporting market transactions is far beyond what is indicated by the relatively small capital cost it represents in the electric power industry.

Compared with the steady increase of demand and generation, however, transmission investment declined over the same time period. In 1972 approximately 30GW generation was added, supported by $7.4billion (in year 2004 dollars) in transmission investment. In 2001, 40.6GW generation was added with only $4.6billion in transmission. By the year 2003, the numbers further diverged to having 52.4GW of new generation versus $3.9billion invested in transmission. Normalized transmission capacity measured in MW-miles/MW-demand and MW/MW-demand is declining at annual rates of 1.5% and 1.6%, respectively (see llirst, 2004). The market environment strains the system further because merchant power pladts competing or short and long-term contracts with multiple buyers are encouraged to transfer larger quantities of electricity over longer distances more frequently to capture interregional market opportunities, raising power flow patterns significantly different from the projected scenarios in system planning. As a result, transmission loading relief (TLR) procedures, which dictate a certain percentage of the power transactions which cause the monitored transmission overloading to be curtailed, have been called frequently for managing transmission utilization to prevent overload situations that put the system at risk.

II. Methodology

The Study Area

Enugu is located in the south eastern region of Nigeria. The city has a capital of Enugu and has a population of 772,664 according to the 2006 Nigerian Census. The state is predominantly rural and agrarian, with a substantial proportion of it working population engaged in farming, trading, and manufacturing. Electricity supply is relatively stable.

Sample Size

The Yaro Yamen formula was used to determine the sample size of the study this is given by equation

$$n = \frac{N}{1+N(e)^2} \qquad 3.1$$

n : sample

N : Population

e : Limit of tolerance error (5%)

N : 52,200

$$n = \frac{52{,}200}{1+52{,}200\,(0.05)^2}$$

$$n = \frac{52{,}200}{1+130.5}$$

n : 400 approximately

Sample size = 400

Sampling Procedure

The research is concentrated on, random sampling. This demonstrates that the participants within the sampled area are both customers and staff. Furthermore, questionnaires were dispatched and the validity of tile replies were analysed and results that best reflects the attitudes customers.

The purpose of this research deals with management of electricity in Enugu Distribution Company. Hence only individuals and staff alike of Enugu Distribution Company are engaged with degree of knowledge of the company that can realistically be expected to provide answer. A sample of four hundred and twenty (420) was distributed for the study, and Four hundred and five (405) of the questionnaire were correctly filled and completed.

Nature and Sources of Data

The nature and sources of data used in this study consist ofprimary and secondary data. Theprimary data was collected by the researcher. The secondary data was collected by the researcher through third parties; from books, published articles, publications and the internet.

Method of Data Analysis

Descriptive statistics such as frequency, percentages and weighted means were used in analysing the research questions while the z-test statistics was used to analyse the hypotheses at 5% level of significance. The formula for z-test statistics is given as:

$$Z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu 1 - \mu 2)}{\sqrt{\frac{(SD_1)^2}{n_1} + \frac{(SD_2)^2}{n_2}}} \quad \ldots\ldots$$

These analyses were done using a well coded Statistical Package for Social Sciences (SPSS) version 21.

RESULTS

Summarized results of the questionnaire and also gives the value for the level of involvement of various categories of respondent described in the methodology. The results are presented in qualitative and quantitative form including; percentages, tables, weighted means and standard deviation to illustrate the level of understanding of cost by respondents and the general understanding of electricity management by customers which form the basis of this assessment. Each of the questionnaire questions produced a different set of results that can be used to analyse the study.

SUMMARY

In a deregulated electricity market, there is a serious competition among the market layers. The distribution companies at different locations have different tariffs for same category of consumers. A critical analysis of these disparity in tariffs gave rise to the question of effective cost management which will in turn reduce the cost of running these stations, but to reduce these costs needs a proper understanding of the various items that contribute to these costs as well as the items that will improve efficiency thereby getting tile consumers loyalty. The work analysed the inherent cost of building these stations which determines the profitability of tile distribution companies and on which basis the tariffs are set. It further analysed the factors that affect the customers and their understanding of the entire deregulation of electricity market. The model established that given a good understanding of these Factors that affect tile cost of distribution that a uniform and cheaper tariff can be achieved with a maximum profit amongst all the players in the electricity market.

CONCLUSION

A total of 420 questionnaires were administered and 405 were filled and returned while 15 were not returned. Various questions were raised. These questions bothered on seven different parameters which include grid connection, metering, non-metered customers, maintenance and running costs, taxes and levies, price regulation and quality of power to know the best approach in determining costing of electricity in EEDC. Two hypotheses were formulated and then tested and the results obtained were found to accept the null hypothesis.

The first hypothesis showed that the calculated z-value of 1.07 is less than the critical value of 1.96 with 405 degrees of freedom at 0.05 level of significance. Since the calculated z-value is less than the critical value, the null hypothesis is accepted. Therefore, there is no significant difference between proper electricity cost understanding and the possibility of an improvement. Thus, proper electricity cost understanding practices have significant relationship with the possibility of improvement.

RECOMMENDATION

EEDC should have better record keeping as it became very difficult to obtain the actual values of buildings of each of their twelve substations.

EEDC workers should be regularly trained with the modern technology as to improve on the overall distribution system performance which in turn equip them with the proper cost management skills needed.

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