

An Economic Assessment of the Reform of Nigerian Electricity Market

Makwe J.N.¹, Akinwale Y.O.^{2,*}, Atoyebi M.K.²

¹Akintola Williams Deloitte, Energy Group, Lagos, Nigeria

²National Center for Technology Management, Obafemi Awolowo University, Ile-Ife, Nigeria

Abstract There is no doubt that there is high level of inefficiency in the Nigerian Power sector. The power generation capacity available is far below the estimated growing demand for electricity. This paper therefore critically assessed the proposed reform of the electricity market in Nigeria. It highlighted some of the challenges such as severe electricity crisis due to the appalling state of power infrastructures, double digit transmission losses and low tariffs. An empirical investigation was conducted using a Linear Programming optimization model via General Algebraic Modelling System (GAMS) to analyse the pre and post electricity reform era. The paper concludes that the reform would be beneficial to the country. Albeit, the study identified that an upward review of prices and reduction in transmission losses are essential in incentivising investor but the success of the reform depends on government commitment and huge investment.

Keywords Electricity, Power, Tariffs, Market, Transmission, Generation

1. Introduction

Economic growth, development and national security of any nation are crucially dependent upon the adequate provision of electricity supply to the required industries. There seems to be a strong correlation between electricity and economic development. Until recently, government has total control over power utilities in most countries of the world. This was as a result of the provision of maximum social welfare with lowest cost to the populace. However, these utilities become huge deficits that cannot be sustained by the government treasury. Hence, there is a paradigm shift from a natural monopoly system of power sector to a relative competitive one. According to World Energy Outlook[1], an estimated average of 1.5 billion people which is an equivalent of 22% of the world's total population still suffers from adequate electricity and majority of these people are in Sub-Saharan Africa and rural South Asia. The most important factor for the reform is finance[2]. The electricity industries in most African countries are in poor state which need huge amount of human and financial resources to revamp the industry. Estache et. al[3] noted that 60% of Sub-Saharan African countries engaged in some form of reform in late 1990s. They suggested that the industry seems to have improved in technologies and commercial practices since the reforms. This suggests that reforms have played some positive impact on their power sector. Some countries

like Senegal and Mauritania faced some challenges in the transition process during reform. Woo et al[4] identified market power, rising marginal cost and financial insolvency as some of the consequence of such flaws. However, despite these experiences, more countries are adopting electricity reforms as a panacea for increased investment and efficiency in the industry.

The plan of Nigeria government is to commercialise and privatise the public sectors since the period of Structural Adjustment Program (SAP) in 1986. This arises as a result of inability of government to meet its liabilities that triggered from these sectors. A good example is the Nigeria Telecommunication industry which was initially operating under the monopolised market of NITEL which was recently privatised. The industry is now competitive and reaping the benefit of a liberalised market by charging the customers a lower cost.

The power utility - initially called National Electric Power Authority (NEPA) but now Power Holding Company of Nigeria (PHCN) - is a natural monopoly, which is state-owned. The industry is vertically integrated such that generation, transmission and distribution segments were managed by NEPA. Over the years, the monopoly has been fraught with poor service delivery, operational losses, distribution losses, poor management and maintenance, under-investment and obsolete facilities. With the passed Reform Act, the industry would be unbundled and privatized to attract the needed resources to boost the sector. This would allow for competition in the generating segment while both transmission and distribution segments remain as private monopolies. The reform is expected to generate some economic implications for the citizens and the prospective in-

* Corresponding author:

yemiiakinwale@yahoo.com (Akinwale Y.O.)

Published online at <http://journal.sapub.org/ep>

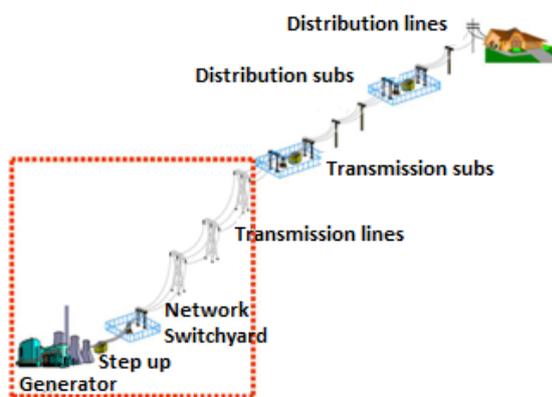
Copyright © 2012 Scientific & Academic Publishing. All Rights Reserved

vestors. This study would therefore review the reforms so as to determine its impact and transmission network on private investor's incentives with emphasis on price and distribution losses. This paper is divided into five parts. Section 2 focuses on the theoretical frameworks of the market structure. Section 3 discusses electricity industry and reforms in Nigeria. Section 4 presents the methodology and analyse the results while the last section concludes the paper.

2. Theoretical Frameworks of the Market Structure

This section discusses the economic theories of a natural monopoly and a competitive market. This would proffer a better understanding on how firms interact in a market structures.

Electricity market was known to be a vertically integrated monopoly market with its various segments- generations, transmission, distribution, and retail supply- managed by a single firm. Fig. 1 below shows a typical structure of the electricity market from generation to distribution.



Source:[5]

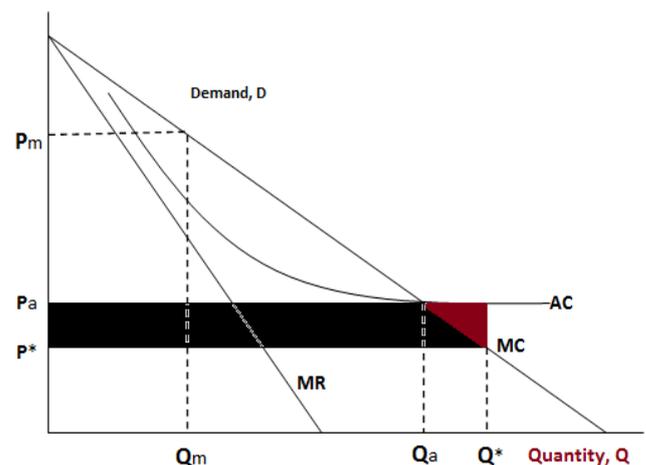
Figure 1. A typical structure of the electricity market

The initial thought of the industry as a wholly monopoly structure has recently been challenged which has led to the privatisation of the sector by many countries¹. Many developing countries have followed the same trend because of the vital role the power sector has played to their economic growth and development². Also, different countries engage in different types of reforms. These reforms could be a combination of competitive market, regulated private market and/or state-owned.

2.1. Natural Monopoly

This market structure usually arise when there is a huge

capital investment/ sunk cost associated with the provision of such goods/services and which the service cost becomes low when it is only produced by a single firm rather than two or more firms. Newberry[6] noted that this is a situation where a single firm can satisfy the entire market demand for a range of goods and services at lower cost. It can be deduced that electricity market in most African countries is a natural monopoly because it is usually state owned enterprise. Sioshansi[7] identified economics of scale and scope, vertical integration among other benefits as the main reason for natural monopoly. The cost structure of a natural monopoly has been assumed to have declining long-run average cost and a constant marginal cost. As a monopolist, the firm could set prices above marginal cost by exercising its market power, if left unregulated. This could be shown in fig 2 below



Source: [8]

Figure 2. Graphical Representation of Natural Monopoly

From fig. 2 above, if the monopoly is left unregulated, it would exercise its monopoly power to make a monopoly profit at price P_m and the quantity produced would be Q_m . On the other hand, if government sets price equal to Average cost (AC) then Q_a would be produced and the firm would break-even. However, government seeks to maximize social welfare of such goods/services and limit monopoly power. It would set price (P^*), which is equal to marginal cost (MC) so that the quantity, Q^* , is produced. Unfortunately, the monopoly would lose at price, P^* and would rather prefer to shutdown. To keep the monopoly in business, government would have to pay for these losses (which are the sum of the coloured area) through subsidies raised from government revenue (tax revenue). Unfortunately in recent times, most governments do not have the sufficient resources to meet these losses as well as the investment requirements of the natural monopoly. As a result, the pressure on its scarce resources had led to negligence in its obligations in state owned enterprise. Therefore, it would not be unusual to expect poor performance in state owned enterprise in developing countries as well as in developed countries.

Carlton et al[8] suggested that less incentive to maximize profit in State owned enterprises could be a plausible reason

¹ Developed countries like UK, and Norway; emerging countries like India, China among others

² Banks[9] argued that approximately 120 developing countries have implemented the privatisation program which have generated approximately \$410 billion between 1990 and 2003.

for inefficiency and had possibly triggered the privatization theory in many countries.

2.2. Privatisation

Privatisation arises when government transfer its ownership rights in the public sector to the private organisations. This act is intended to curb the excessive political interference of the government[10]. Bos[11] and some other literatures showed that privatisation leads to improved efficiency, better performance through the interplay of market forces, reduction of National debts among others. Fig. 3 below shows the graphical comparisons between competitive and monopoly market.

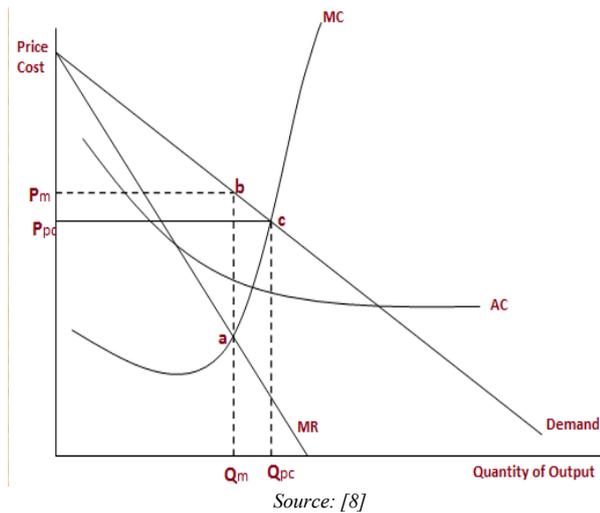


Figure 3. A Standard Analysis of the comparison between Monopoly and Competitive Markets

From Fig. 3 above, it would be observed that the quantity produced by a monopoly, Q_m , is less than that of a competitive quantity, Q_{pc} at their respective prices, P_m and P_{pc} . It would also be observed that the price of a competitive market is lower than that of the monopoly. If a monopoly market exists, it would be a cost on the society. This cost is termed the deadweight loss, which is the area *abc*. This explains why it could be more beneficial to have a privatized sector with a competitive approach than a monopolistic approach. Given the implication of a monopoly firm, one might ponder why most reforms still transfer monopoly from the state owned enterprises to (foreign/domestic) private firms. This is apparent in the UK reform, where the transmission and distribution segments are private monopolies. In a regulated private monopoly, the private sector operates and manages most part of the utility but under the supervision of an independent regulatory body.

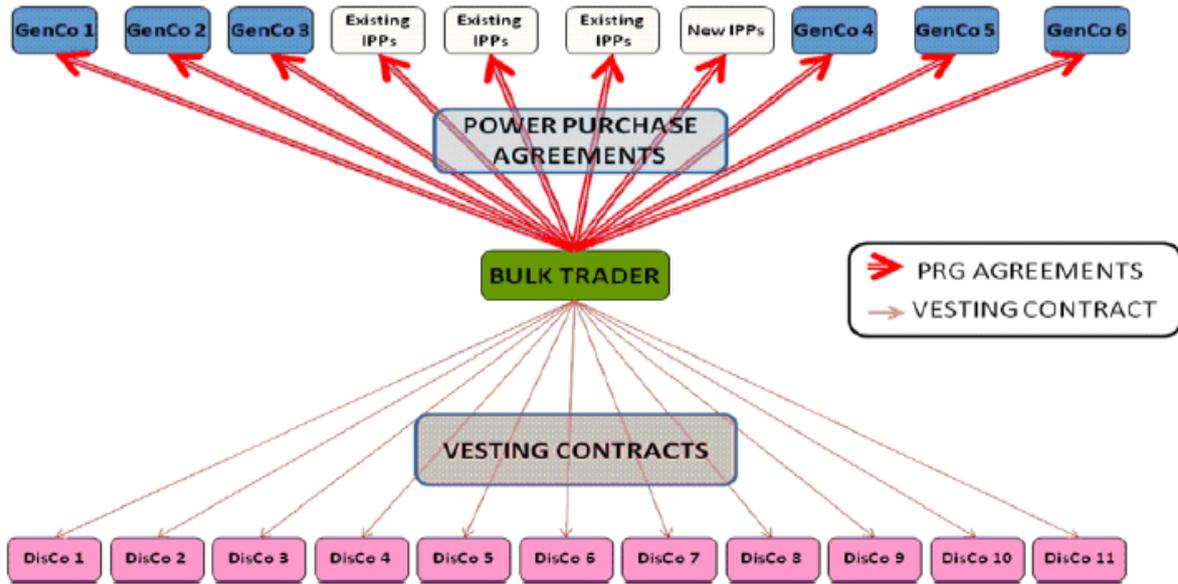
3. Electricity Industry and Reforms in Nigeria

The first generating plant in the electricity market in Ni-

geria was installed in 1896. Despite the fact that many bodies had been established by various legislative councils since 1950, the level of development in the power sector had been at a slow rate[12]. In 1950, Electricity Corporation of Nigeria (ECN) was established to be responsible for electricity supply and development in Nigeria. In 1962, Niger Dams Authority (NDA) was established by an act of parliament. This authority was responsible for the construction and maintenance of dams and other works on the River Niger and other hydro generating plants. Okoro and Chikuni[13] noted that the electricity produced by the NDA was sold to ECN for distribution and sales at utility voltages. In 1972, Nigerian Electric Power Authority (NEPA) was established by the Government-sponsored merger of the ECN and NDA. NEPA has since operated as a government-controlled monopoly responsible for power generation, transmission, and generation. Sambo[12] argued that prior to 1999; the power sector did not witness substantial investment in infrastructural development. He stated that new plants were not constructed and the existing ones were not properly maintained, bringing the power sector to a deplorable state.

Following the introduction of the Electric Power Sector Reform Act in 2005, NEPA was transformed into a Power Holding Company of Nigeria (PHCN) which was subsequently unbundled into 18 companies, including 6 generators, 11 distributors and one transmission company. These companies are responsible to carry out the functions relating to the generation, transmission, trading, distribution and bulk supply as well as resale of electricity[14]. The reform has been able to introduce new set of players such as the Independent Power Producers (IPPs), Nigeria Electricity Liability Management Company (NELMCO). The power sector is now regulated by the National Electricity Regulatory Commission (NERC) under the Federal Ministry of Power. NERC has issued about 29 power generation licenses to independent power producers since 2006.

According to Makwe[15], a wholesale competitive market, like the UK reform, is intended for the generating segment while the distribution companies would be privatized regional monopolies. The Generating Companies (GENCOs) would run concurrently with licensed IPPs. The transmission company (TRANSCO) would remain a state-owned monopoly. TRANSCO shall also play the role of a system operator and would be responsible for transmitting and dispatching function. NERC, the regulatory body, was also established. It would, among other functions, ensure fair play and transparency in the wholesale market. It would oversee the activities of TRANSCO and Distribution Companies (DISCOs) to ensure adequate third party access. A Rural Electrification Fund (REF) was also established to enhance electricity affordability by low income consumer. A Bulk trader, Nigeria Bulk Electricity Trading Plc (NBETP), was established and it would be responsible for buying power from the generating companies and the IPP (via PPA) and resell it to the distributors (via a vesting contract) as shown in fig. 4 below.



Source: [16]

Figure 4. A Graphical Representation of the Proposed Nigerian Reform

The main reason for the establishment of the Bulk Trader is to ensure a gradual and orderly transition to a competitive market. As the market evolves, however, bilateral contracts are anticipated to exist between generating companies/IPP and distributing companies. At this stage, some distribution companies are commercially viable to purchase power directly from the generators

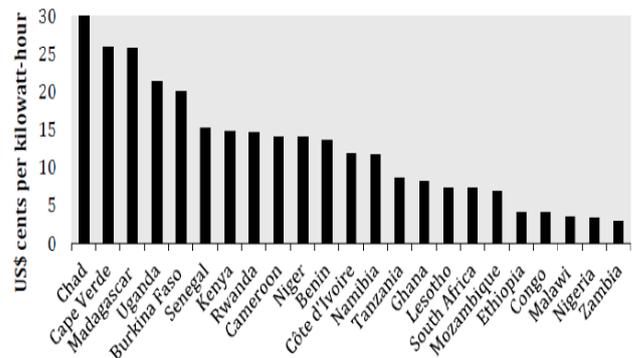
3.1. Challenges Facing Electricity Market in Nigeria

The challenges facing the power industry in Nigeria ranges from generation to distribution of electricity. In the 1950s, the demand for electricity was below its supply. The industry was able to meet the country’s need at that period. The demand for electricity gradually increased and later outstripped supply as industrialisation come in. The estimated total installed capacity of the combined hydro and thermal power stations is 7,941.1 MW as at December 2008. Meanwhile the power generation capacity available is 4,428 MW of which 3,273MW is from PHCN while 1,155MW is from IPPs. Currently, it is estimated that the demand for electricity is approximately 10,000MW and it is expected to grow in the future. There are three hydro and seven thermal generating stations.

Ibitoye and Adenikinju[17] stated that ageing of power plants, poor maintenance and dearth of funds are some of the factors that could be responsible for the sub-optimal operation in the power sector. According to Presidential Task Force on Power Project (PTFP)[16], the sector needs, on a yearly basis, N520 billion (US\$3.5billion) to increase generating capacity from approximately 4000MW to 13000MW by 2013. Also, the transmission network is overloaded with a wheeling capacity less than 4,000 MW. There are significant line voltage and power losses, as high as 25% compared with 3% in the US and 0.5% in Japan, in the transmission systems due to the large average distances between 300 and 500km over which electrical energy is distributed. Low transmission

grid voltages, typically 330kV and 132kV compared with 765kV in developed countries also cause significant transmission and distribution losses. To worsen the demand shortage, Nigeria experiences a double digit transmission and distribution losses, which are quite large by international standards[18]. The losses could be attributed to the poor and obsolete state of the transmission network. Therefore, a robust transmission network would be vital in connecting to the north. Hence, Borenstein et. al[19] stated that an efficient transmission capacity would reduce market power, increase competition and thereby reduce regulatory interventions.

Energy mix is another challenge facing the power sector in Nigeria. The electricity sector has been powered by hydro and thermal plants. These have not been sufficient to meet the electricity need of the country. Nigerian is said to be blessed with abundant solar and wind energy, which are yet to be fully tapped in generating electricity[15]. According to Foster et al[20], Nigerian tariff is one of the lowest in Africa as could be observed in fig. 4. He stated that the reform act passed in 2005 brought about a review of the tariff from \$0.04/kwh to \$0.06/kwh in 2009. They also noted that it would be increased to \$0.07/kwh in 2011.



Source: [20]

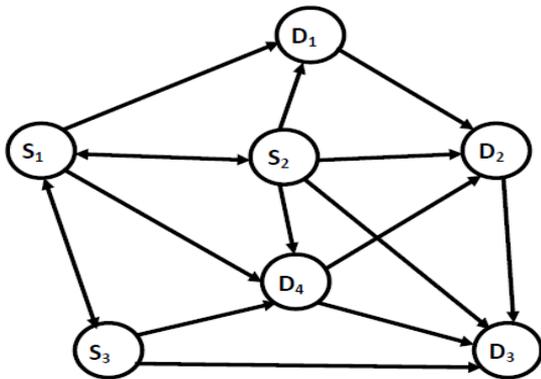
Figure 5. Electricity tariff across some African countries

Government anticipate that the new pricing formula, Multi Year Tariff Order (MYTO), would be cost reflective and it is hoped that the tariff review would attract investors into the market.

4. Research Methodology and Results Analysis

A LP optimization model is used in this study to analyse the Nigerian Electricity market, pre and post reform. The adopted model is simple and tried to replicate the characteristics of the Nigerian Electricity Industry as a single system/network. The principal use of optimization models in the electricity industry is for scheduling of production at generating plants. The model, solved via General Algebraic Modelling System (GAMS), estimates the profitability of the system which could incentivize private investors under two scenarios. The programme selects the least-cost options among the given plants' capacities with their transmission costs (between the plant and demand points) and the transmission loss.

The model examines the market performance of the industry under two scenarios, which are base and expanded scenarios. The base scenario assumes the pre-reform state of industry as a single organisation, while the expanded scenario tends to capture the post-reform. With the reform, it assumes that additional capacities have been installed in the generating segment. Also sensitivity analysis was run on electricity price and transmission losses parameters and evaluated the impact on the system. The model is a simplified transportation problem, where the generating plants represents the supply nodes (S_n) and the distribution companies (points) are the demand nodes (D_n). The model is design to include the transmission network between nodes. Hence, the model is similar to a typical network in fig. 6 below.



Source: [21]

Figure 6. A Typical Networking

Each supply node is captured as the plants installed capacity. Each demand node captured the aggregate energy requirement of each region. Demand at each node was assumed to be constant. Transmission is assumed to flow be-

tween supply nodes, from the supply nodes to the demand nodes and transshipment from a demand node to another, as shown, as shown in fig. 6 above.

Table 1. Base Model Data Adopted

Electricity price/kwh	Distribution loss (α)	Base demand requirement (β)	Peak demand requirement (δ)	Supply cost (C)/kwh
\$0.03	30%	40%	70%	\$0.13

Source: [16]

4.1. Mathematical Model and Assumptions

Objective function: chooses plant capacities and outputs as well as transmission costs that best maximises investors' incentives:

$$Max B = \underbrace{\sum_{i=1}^n P * SD_i}_{TR} - \underbrace{\sum_{i,j} Tc * (Pf_{ij} + Nf_{ij})}_{TTC} - \underbrace{\sum_{i=1}^n C * QS_i}_{TSC}$$

Where, TR= Total revenue, TTC = Total Transmission Cost, TSC = Total Supply Cost

Subject to:

Net flow balance:

$$\sum_j X_{ji} - \sum_j X_{ij} = QS_i - SD_i * (1 + \alpha)$$

This means that the total electricity supplied to a given node must equal to its demand. The distribution losses parameter (α) in the constraint means that plants must produce sufficient electricity to meet the fixed demand and distribution losses.

Where, $X_{ij} = Pf_{ij} - Nf_{ij}$: it means that the net flow of electricity in and out of a node must satisfy the demand requirement of that node.

- Non-negativity of Net flow:

$Pf_{ij}, Nf_{ij} \geq 0$: it means that all flows in or out of a node must be non-negative

- Net flow bounds:

$Pf_{lo} \text{ or } Nf_{lo} = 0$: the lower bounds of all flow in or out must equal zero

$Nf_{up} = -\infty; Pf_{up} = +\infty$: the upper bounds of all flow in or out are infinite

Demand bounds (D):

$D_{up} = \delta * \check{D}$: upper demand bound is a function of peak load requirement on maximum demand. Hence, the upper bound can never exceed the maximum demand.

$D_{lo} = \beta * \delta * \check{D}$: lower demand bound is a function of base load requirement on upper bound

- Supply bounds(Q):

$Q_{up} = Q$: upper supply bound is a function of maximum supply capacity at each plant. As such, the output from each plant can never be more than its available capacity.

$Q_{lo} = 0$: lower supply bound is equal to zero; hence, it can never be negative.

The maximum demand requirement and the maximum

supply capacity were assumed fixed. The units are in Kilowatt hour, as can be seen in table 1 to 3 below. The plant capacities were in MW as obtained from[16] but were converted to KWh by assuming that the plants run hourly. Transmission cost (\$) between nodes was estimated in proportion to the distance between the nodes.

Table 2. Expanded Model Data Adopted

Demand	Maximum Requirement-D (KWh)	Supply plants	Maximum capacity-Q (KWh)
Abuja	835000	kainji	760000
Benin	1000000	Jebba	578000
	2440000	Shiroro	600000
Enugu	1017000	Geregu	414000
Ibadan	1193000	Sapele	1020000
Jos	507000	Ughelli	972000
Kaduna	520000	Afam	776000
Kano	590000	Egbin	1320000
PH	773000		
Yola	176000		

Table 3. Other Assumptions Adopted

Demand	Maximum Requirement (KWh)	Supply plants	Maximum Capacity (KWh)
Abuja	835000	Kainji	760000
Benin	1000000	Jebba	578000
Lagos	2440000	Shiroro	600000
Enugu	1017000	Geregu	414000
Ibadan	1193000	Sapele	1020000
Jos	507000	Ughelli	1052000
Kaduna	520000	Afam	1418000
Kano	590000	Egbin	1320000
PH	773000	Ibom-power	300000
Yola	176000	Omotoso	335000
		Papalanto	335000

4.2. Analysis of Results

This section discusses the result obtained from the Linear Programming Optimisation model via General Algebraic Modelling System (GAMS) on pre and post reform of the electricity market. Sensitivity was also run on electricity prices to evaluate the impact on the system and demand satisfied. Fig.7 below shows that price of electricity would influence the performance of the industry base on the based model using table 1.



Figure 7. Impact of Different prices on the Based system

The system is better off when electricity prices are higher. The model revealed that the current electricity price of \$0.03/kwh is not favourable for the system. This could explain the huge losses of the pre-reform industry, which the government is obliged to subsidize. It could suggest that PHCN was producing even when it is not financially viable to do so. Once the system becomes more profitable, the subsidization burden would be history. If the current low prices still persist in post-reform, it could deter potential entrants to the market. This suggests to the government that increase in electricity tariff would be beneficial to industry. However, it is important that government ensures that prices are fair to both power producers and consumers. Otherwise, consumers would be exploited and firms would have excess rent at their disposal. It should be noted that the model did not adequately capture the demand side. Hence, there is no limit at which prices could rise beyond which consumers might not afford it.

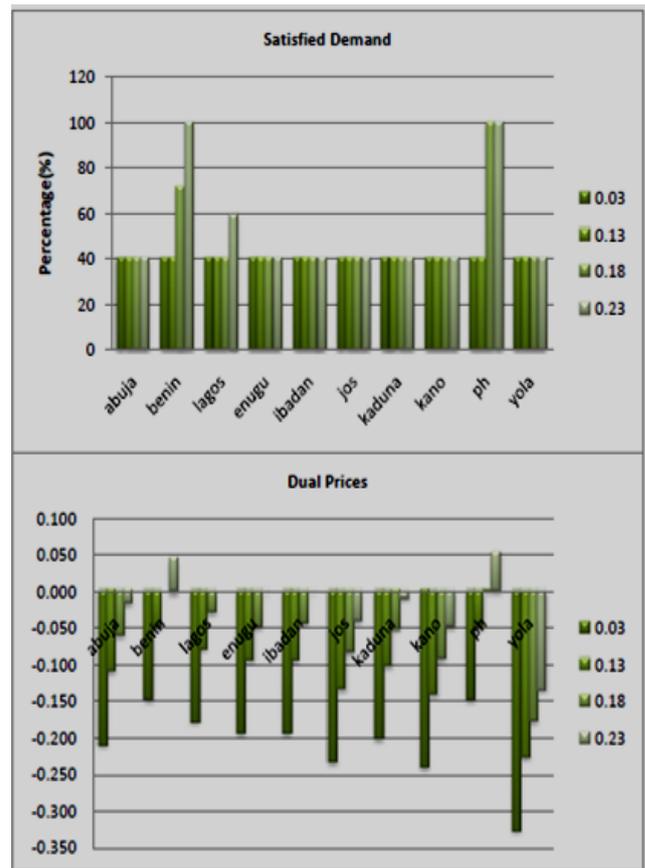


Figure 8. Impact of Different Prices on Satisfied Demand (%) and Dual prices

Fig. 8 above shows that demand satisfied is influenced by prices. It could be observed that demand could be satisfied beyond the lower bound of 40% only when prices are as high as \$0.18/kwh and above. At \$0.03/kwh, it would be observed that only minimum requirement was satisfied as the dual prices were all negative. This explains why the system was at loss as shown in Fig. 7. At \$0.23/kwh, demand satisfied at Benin, Lagos and PH were 100%, 60% and 100% respectively, while at \$0.18/kwh, demand satisfied at Benin and PH

were 71% and 100% respectively. It pays the system to satisfy demand beyond the minimum at these regions at these prices. This is evidenced by the dual prices as they are positive. On the other hand, Abuja, Enugu, Ibadan, Kaduna, Jos, Kano and Yola had 40% because it does not pay to satisfy demand beyond this level as revealed by the negative dual prices. However, demand at these points would not have been satisfied if not for the lower bound constraint on satisfied demand. The plausible reason for low satisfied demand, as expected, could be the transmission losses as these demand points are further away from the supply points. The further away from source, given the distribution losses, the more costly it is to satisfy demand. This suggests to government to consider using non-grid supply for demand points farther from supply and/or invest to reduce distribution losses. For example, solar or wind power could be used in Abuja, Yola, Kano and Jos as these regions have been said to have solar energy.

From price sensitivity, any prices lower than \$0.23/kwh results in distribution losses. Therefore, sensitivity analysis was run for distribution losses with electricity price constant at \$0.23/kwh so as to evaluate the impact on the system and demand satisfied as shown in Fig. 9 below.

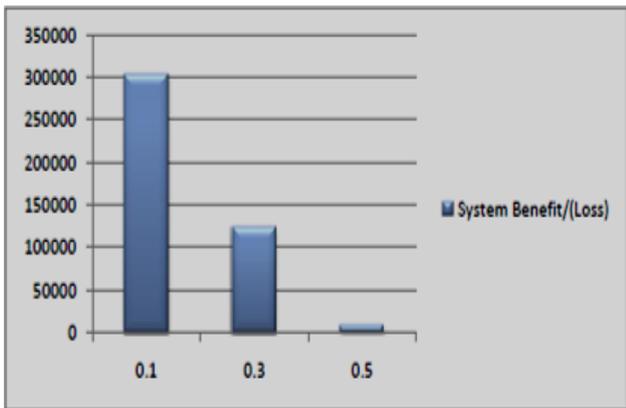


Figure 9. Impact of Different Distribution losses (%) on the System

Fig. 9 above shows that the system would be viable when transmission losses are as low as possible. Apparently, at 10% % international standard as noted by[20], the system showed a very high performance as compared to 30% and 50% distribution losses. It is important that government should not underestimate the impact of a poor transmission network on industry. Transmission play important role in reducing cost of electricity supply and subsequently reduces price[22]. Therefore, government should be committed to the investment plans it had proposed for the supra-grid transmission network.

The expanded model assumed that the reform opened the generation segment to competition. Hence, capacity at supply points was expanded. The base model was replicated but assumed that capacity at Ughelli and Afam were increased and Ibom-power, Omotoso and Papalanto were new installed plants. These are independent power plants as noted in Sonibare[23]. The sensitivity analysis was run on electricity prices so as to evaluate the impact on the system.

Fig. 10 above shows that the expanded model is better since there are additional plants. The system became better from \$0.18/Kwh compared to the base model, which was better at \$0.23/Kwh. This could suggest to the government that a competitive wholesale market could result in lower prices compared to a monopolized market. Hence, the electricity reform could be more beneficial to Nigeria. Even where losses occurred, the impact would be less compared to the base model.

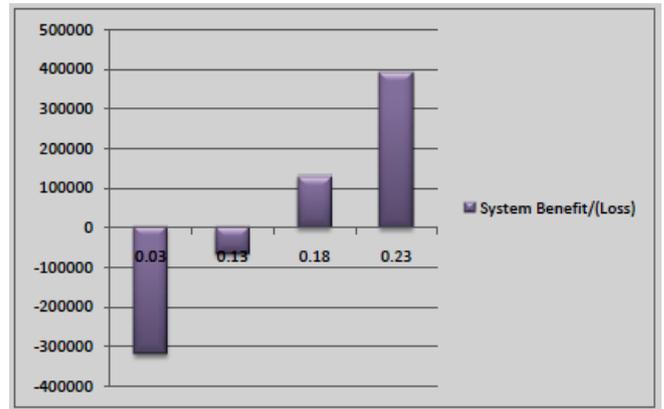


Figure 10. Impact of Difference prices on Expanded System

Fig. 11 below shows that higher prices and increased supply capacity would result in more demand being satisfied. It was observed that at either \$0.18/kwh or \$0.23/kwh demand at Abuja, Benin, Lagos, Enugu, Kaduna and PH were satisfied beyond the minimum requirement as compared to the base model, where only three demand points were satisfied. The dual prices show that it would pay the system to satisfy more demand. At lower prices, lower demand bounds of 40% would be satisfied in all regions.

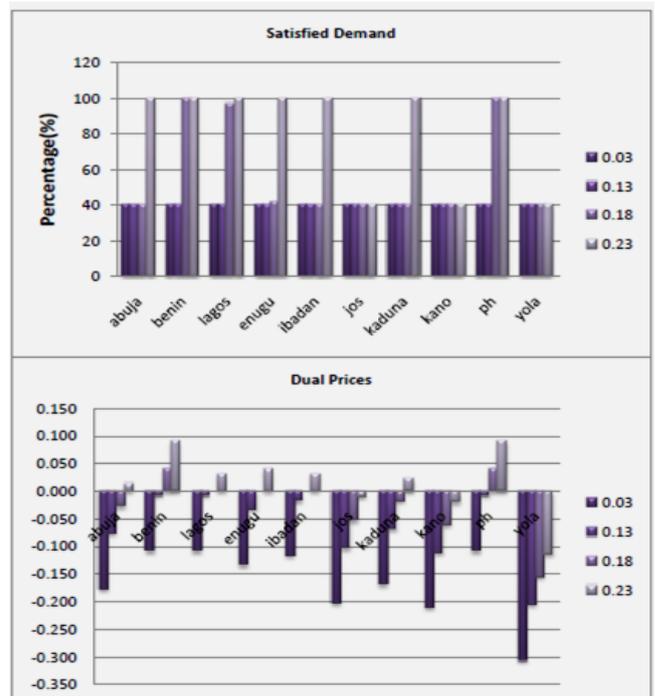


Figure 11. Impact of Different Prices on Satisfied Demand (%) and Dual Prices on Expanded System

Sensitivity was also performed on distribution losses at price \$0.23/kwh to evaluate the impact on the expanded system and demand satisfied. Fig. 12 below shows that the system is better in the expanded model (\$434,794) than in the base model (\$303,240) because of the additional capacities or plants. It could be possible that the new plants were able to satisfy some demand cheaper than the existing plants. It suggests to the government that adequate investments in transmission network would be most beneficial to the success of the reform compared to the base model.

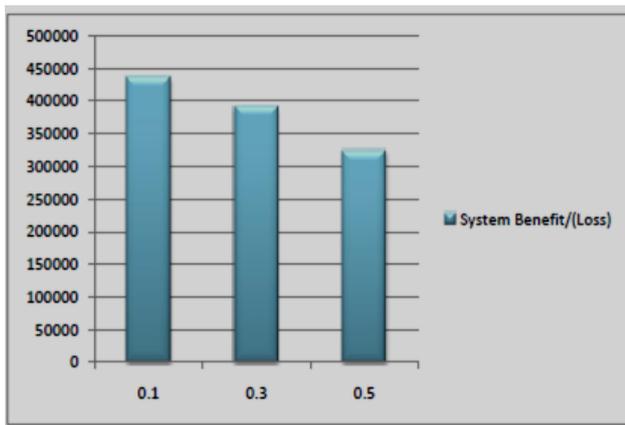


Figure 12. Impact of Different Distribution losses (%) on the System

5. Conclusions

The Nigerian power sector is in a poor state both financially and administratively. The infrastructures are sub-standard, power plants are under operating, transmission losses are high, electricity tariffs are low and black outs are common in the country. The investment need of the sector is so great that government alone cannot bear the burden alone. This had necessitated the sector reform. The reform would allow the unbundling of the industry: a competitive generating segment and monopolized transmission and distribution segments. The reform has also initiated an upward review of tariffs. If the reform is properly designed and implemented, it would promote the flow of both domestic and foreign investment and manpower resources into the sector. From experiences from other countries, this would improve electricity supply to meet the growing demand in Nigeria. Subsequently, it would drive the economic development goals of the country.

Using the LP model with the sensitivity analysis, this study analysed the impact of the reform and transmission network on private investors' incentive. It focused on impacts of electricity price and distribution losses on the industry, both pre-reform and post-reform.

The model result revealed that an upward review of electricity price would improve the sector both before and after the reform. This is because more plants would operate when prices are high. Hence, more demand would be met. However, prices could be lower in post-reform than in pre-reform because of the competitive wholesale market. The model also revealed that adequate investment in the transmission

network would be beneficial in both pre-reform and post-reform.

This recommends to the government that upward review of prices would make the market more viable for investment especially in the generating segment. Also, it reveals to government that transmission network would play a major role in incentivising firms to invest in the generating segment and ensuring that demand points in the country are met. It also reveals to the government that there is spatial distribution of prices. Hence, a standard price for all plants might not be appropriate. The reform could therefore be a panacea to revamping the ailing industry.

REFERENCES

- [1] World Energy Outlook (2009)
- [2] Williams, J. H. and Ghanadan, R. (2006) —Electricity Reform in Developing and Transition Countries: A Reappraisal || ; *Energy Policy*, Volume 31
- [3] Estache, A., Tovar, B. and Trujillo, L. (2008) —How efficient are African electricity companies? Evidence from the Southern African countries; *Energy Policy*, Volume 36, Issue 6, Pages 1969-1979
- [4] Woo, C., Lloyd, D. and Tishler, A (2003) —Electricity Market Reform Failures: UK, Norway, Alberta and California || ; *Energy Policy*, Volume 31, Issue 11, Pages 1103-1115
- [5] Joskow P. L. (2006) —Incentive Regulation in Theory and Practice: Electricity Distribution and Transmission Networks; *Energy and Environmental Policy* available online <http://ideas.repec.org/p/cam/camdae/0607.html> Accessed: 24/12/11
- [6] Newbery, D. (2000) —Privatization, Restructuring and Regulation of Network Utilities London: MIT Press
- [7] Sioshansi, F. P. (2006) —Electricity Market Reform: What has the Experience taught us thus far?; *Utilities Policy*, Volume 14, Issue 2, Pages 63-75
- [8] Carlton, D. and Perloff, J. (2005) —Modern Industrial Organisation 4th Edition, Boston, London: Pearson Addison Wesley
- [9] Banks, J.P. (2006) —Privatization of the Electricity Sector in Emerging Markets: The Organizational Challenge for Governments; *Electricity Journal*, Vol. 19, Issue 9, Pages 45-54
- [10] Laffont, J. (2005) —Regulation and Development United Kingdom: Cambridge University Press.
- [11] Bos, D. (1991) —Privatization: A Theoretical Treatment || New York: Oxford University Press
- [12] Sambo, A.S. (2008) — Matching Electricity Supply with Demand in Nigeria. IAEE, fourth quarter, pages 32-36.
- [13] Okoro, O. and Chikuni, E. (2007) —Power Sector Reforms in Nigeria: Opportunities and Challenges; *Energy Journal*, Volume 18, Number 3, Pages 52-57
- [14] National Technical Working Group, 2009. Report of the Vision 2020 on energy Sector. Pages 63-70

- [15] Makwe, J. (2011) — The Nigerian electricity Market. University of Aberdeen Business School. 2, Pages 294-325 Accessed: 18/12/2011 08:20
- [16] Presidential Task Force on Power (2011) <http://www.nigeriaelectricityprivatisation.com> Accessed 8/12/11
- [17] Ibitoye, F. I. and Adenikinju, A. (2007) —Future demand for electricity in Nigeria; *Applied Energy*, Volume 84, Issue 5, Pages 492-504
- [18] Iwayemi, A. (2008) —Nigeria's Dual Energy Problems: Policy Issues and Challenges; *IAEE Energy Forum*, 4th Quarter, 2008
- [19] Borenstein, S., Bushnell, J. and Stoft, S. (2000) —The Competitive Effects of Transmission Capacity in a Deregulated Electricity Industry; *Journal of Economics*, Vol. 31, No. 2, Pages 294-325
- [20] Foster, V. and Pushak, N. (2011) —Nigeria's Infrastructure: A Continental Perspective; *Policy Research Working Paper*, World Bank
- [21] Taha, H. A. (1997) —Operations Research: An Introduction; New Jersey: Prentice Hall
- [22] Jamasb, T. and Pollitt, M. (2007) —Incentive Regulation of Electricity Distribution Networks: Lessons of experience from Britain; *Energy Policy*, Volume 35, Issue 12, Pages 6163-6187
- [23] Sonibare, J. A. (2010) —Air pollution implications of Nigeria's present strategy on improved electricity generation; *Energy Policy*, Volume 38, Issue 10, Pages 5783-5789