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ANALYSIS OF POWER SECTOR PERFORMANCE: NIGERIA AS A CASE STUDY

Ganiyu Adedayo Ajenikoko[1], Adebayo Wasiu Eboda[2], Oluwatomi Adigun[3], Ahmed Olayinka[4] , Sulaimon Oladimeji Oni[5], Lukman Adelowo[6.]

[1,2,3,4,5,6] Department of Electronic and Electrical Engineering, Ladoke Akintola University of Technology, P.M.B, 4000, Ogbomoso, Nigeria.

Corresponding Email: ajeedollar@gmail.com

Abstract

Electric power supply is one of the basic infrastructural, requirements for industrialization, productivity and growth in any economy as well as improvement in the quality of life. The Nigerian electricity industry has undergone long overdue reform and has been deregulated. The new institutions and regulations are to be overseen by an independent regulator. Despite the deregulation and reforms, electricity generation is epileptic. This study analyzes the performance of Nigerian power sector so as to suggest possible means of ensuring improvements of the sector. Specification and estimation techniques were used for a period of eleven years.. Secondary data were sourced from Central Bank of Nigeria (CBN) Statistical Bulletin of 2018 and Nigerian Electricity Regulatory Commission (NERC). The performance of the power generated was evaluated using the overall efficiency and thermal efficiency.The results showed that the average value of the overall efficiency for the ten years period of study was 15.68% while the thermal efficiency had the average value of 15.37%. The result confirmed that deregulation of power sector has no effect on the efficiency of Nigerian power sector when the results were compared with the international best practice standards which are 30% and above for overall efficiency and 45% and above for thermal efficiency. The study therefore suggested possible strategies for efficient power sector improvement.

Keywords: Electric Power, Nigerian Electric Industry, Deregulation, Reform, NERC, CBN, Specification Technique.

I. Introduction

Power generation is one of the major components of power delivery process to consumers. Power generation must be in cycle with population growth and productive capacity to drive meaningful economic growth [1]. The reliable and adequate power supply produce a multiplier effect which goes a long way in tackling the problem of poverty, unemployment and prevalent absence of technological and structural changes that are commonly seen in many developing countries like Nigeria [2, 3].

Nigeria with a population size of over 170 million has one of the lowest net electricity generation per capita rate in the world despite the abundance of electricity generation sources in the country[1]. Electricity distribution network and voltage profile are very poor thus resulting in more that 50 percent of the populace living without electricity supply. Electricity production and distribution system are weak and susceptible to major setbacks. The weak and inefficient system results from old and decaying infrastructures which are still being operated without major rehabilitations, retrofit or upgrade [4, 5, 6].

Nigeria electricity generation, production and distribution have been an exclusive list of the poorly managed government monopoly under National Electric Power Authority (NEPA) and later Power Holdings Company of Nigeria (PHCN) [3]. The inefficiency as well as inadequate facilities to boost electricity supply in the face of increasing population, vast geographical landscape and an increasing business environment all combine to create electricity supply problems. While demand for electricity is increasing, supply tends to be depreciating. This supply inadequacy has damaging consequential impact on all sectors of the economy and therefore encourages the people to source for alternative, but unhealthy, electricity supply sources via the generators (small power generating sets) [2, 6, 7].

In order to salvage the electricity problem in the country, Nigerian government has initiated many power generation reforms in form of power sector development for the past decades. The major reform was set through the enactment of the Electric Power Sector Reform Act of 2005 [5]. This was intended to restructure the electricity market from monopoly to a more competitive structure. As at the end of 2009, Nigeria has installed electricity capacity of about 8000 MW with only a maximum of about 4,000 MW available. This is made up of a mix of 36% hydro and 64% thermal. The Federal Government is investing heavily in expanding the generation

capacity and is encouraging investments in power production through joint ventures and Independent Power Producers (IPPs), with the hope of increasing the total installed capacity to not less than 15,000 MW [6, 8, 9].

The Presidential Task Force on Power (PTFP) was established by Federal Government in June 2010 to drive the implementation of the reform of Nigeria's power sector. The task force was meant to bring together all the agencies including the Federal Ministry of Power, Federal Ministry of Finance, Bureau of Public Enterprises (BPE), Nigerian Electricity Regulatory Agency (NERC), Nigerian National Petroleum Corporation (NNPC), Bureau of Public Procurement, National Gas Company Limited (NGC) and Power Holding Company of Nigeria (PHCN) that have a role to play in removing legal and regulatory obstacles to private sector investment in the power industry. Its mandate was also to monitor the planning and execution of various short-term projects in generation, transmission and distribution that are critical to meeting the stated service delivery targets of the power reform roadmap [10, 11, 12, 13].

The power sector roadmap was integral part of Infrastructural Master Plan (IMP) launched by Federal Government in 2013, which preceded the Transformation Agenda's Mid-term Report. According to policy statement of the report, Nigeria was to invest heavily in transport, road construction, power, Information Communication Technology (ICT) and water resources in which the power sector had the largest of the expected investments [14]. The report outlined the proposed investment in the power sector which covers investment in four major areas of power generation, transmission, distribution and alternative energy. This study therefore aims at investigating the performance of Nigerian power sector and the impacts of the reforms on electricity supply growth in the country.

a. Overview of Nigeria Power Sector

Nigeria's power sector is made up of 3 major subsectors namely; Generation, Transmission and Distribution system and the power sectors has been operating for many years under the National Electric Power Authority (NEPA) until 2005 [15]. Following the Electricity Power Sector Reform (EPSR) Acts of 2005, NEPA was replaced by Power Holding Company of Nigeria (PHCN). However, there were no remarkable improvements in power supply but at the same time, government continue to inject several billions of naira into the sector annually [12, 14, 16].

The Federal Government on 1st November, 2013 however handed over the PHCN to eighteen successor companies made up of six generation, one electricity transmission and eleven distribution companies to new owners and thus signaling the end of PHCN. With this reform, government hopes that the power sector will drive Gross Domestic Product (GDP) growth so that Nigeria will generate more than the irreducible 40,000 megawatts [13, 17, 18].

The generating companies (GENCOS) are Egbin Electricity Generating Company (EEGC), and those at Sapele, Ughelli, Afam, Shiroro and Kainji. There are also some new Independent Power Producers (IPPs) under the auspices of the Niger-Delta Power Holding Company (NDPHC) [19]. At the end of year 2017, there are currently 77 grid-connected generating plants in operation in the Nigerian Electricity Supply Industry (NESI) with a total installed capacity of 12, 800 MW and available capacity of 7,139.6 MW. Most of the generation is thermal based, with an installed capacity of 9,044 MW and an available capacity of 6,079.6 MW. Hydropower from three major plants accounts for 1,938.4 MW of total installed capacity and an available capacity of 1,060 MW [20, 21, 22].

The Transmission Company of Nigeria (TCN) is currently being managed by a Management Contractor, Manitoba Hydro International (Canada). Manitoba is responsible for revamping TCN to achieve technical and financial adequacy in addition to providing stable transmission of power without system failure [23, 24]. Currently, the transmission capacity of the Nigerian Electricity Transmission system is made up of about 5,523.8 km of 330 KV lines and 6,801.49 km of 132 KV lines. The TCN is made up of two major departments: System Operator and Market Operator[25]. The market operator is a department under TCN charged with the responsibility of administering the wholesale electricity market, promoting efficiency and where possible, competition. The system operator is focused on system planning, administration and grid discipline [26, 27, 28, 29].

The eleven Distribution Companies (DISCOS) are the Electricity Distribution Companies of Abuja, Benin, Eko, Enugu, Ibadan, Ikeja, Jos, Kaduna, Kano, Port-Harcourt and Yola respectively. The coverage areas of the eleven companies are indicated in Figure 1 below [28, 30]:

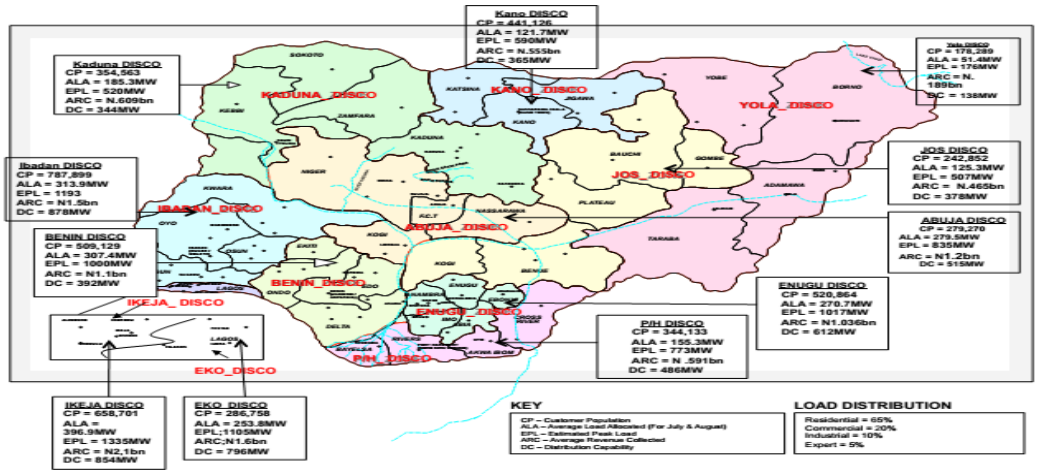

Figure 1: Nigeria Distribution Companies

The present administration is committed to delivering change to Nigeria's power sector to benefit the lives of all Nigerians. Currently, over half of the country population does not have access to electricity and those that do suffer from intermittent power supply. Stable and constant electricity is vital to the economic and social welfare of Nigeria because it is a necessity for the development and progress of Nigeria.

b. Review of Related works

Wara *et al*. (2009) [29] analyzed the various reforms carried out on the Nigerian power sector between the year 1999 and 2007 and its impact on the life of the average citizens. The study efforts employed questionnaires and the result was analyzed through the use of simple percentages and correlation coefficient. The result showed that deregulations and reforms were not improving the power sector of Nigeria yet and recommended that government should continue the rehabilitation of the various power systems in a guided manner to allow a core Nigerian investor, consider alternative sources of energy like solar, tide, biomass, and wind.

Barros, Ibiwoye and Managi (2010) [9] analyzed the productivity change in Nigeria's power sector from 2004-2008 using the Malmquist index with the input technological bias. The results showed that on the average, the Nigerian power sector became more efficient and experience technological improvements. In addition, Isola, (2012) [15] investigated the challenges and prospects of power sector reform in Nigeria by employing a purely descriptive analysis. The study focused on the market structure, market design and supply gap in the electricity generation within the context of power reform. The paper adopted oligopolistic game theory based models of Cournot, Betrand and Supply Function Equilibrium to explain the complex interest groups in Nigeria energy sector and related them to experiences in other countries. The paper concluded with a number of suggestions that could move the power sector forward from its lack luster performance of the years.

Iwuamadi and Dike (2012) [17] analyzed the productivity change in Nigeria's power sector from 1970–2010 using the Malmquist index with Cobb-Douglas Stochastic Production Frontier function. The result showed that the 2005 national electric power reform act produced slight technical improvement. Iwuamadi, Dike and Iwuchukwu, (2014) [16] investigated the power instability in the Nigerian Power Sector from 2005 – 2013 despite several imitative measures by the government. The study found out that, the conceptual objective of the power reforms to remedy inadequate power generation capacity, inefficient usage of capacity, ineffective regulation and high technical losses were being achieved. The results revealed that privatization improved the productivity index.

Ologundudu (2015) [24] investigated the causal and long-run relationship between electricity supply, industrialization and economic development in Nigeria from l972-2010 using the Granger Causality test and the ARDL bounds test approach. The result showed that there was a feedback causal relationship between GDP per capita and electricity supply. In addition, the results showed that industrial development and electricity supply were
important determinants of economic development. The study concluded that for Nigeria to drive economic development through industrialization, the country should fix the electricity supply problem.

Ogbonna, Idenyi and Nick (2016) [22] examined the impact of power generation capacity on economic growth in Nigeria from 1980 – 2015 using econometric techniques. The study used Real Gross Domestic Product

(RGDP) as a function of Power generation capacity in Kilowatt, Gross capital formation and unemployment. The result showed that a stable long run relationship existed between the dependent and explanatory variables and this could be relied upon in taking long run policy decision. The study concluded that there was no causality between power generation capacity and economic growth in Nigeria within the study period. The study therefore recommended that government must ensure transparency in the overall implementation of power sector policy and its attendant reform agenda.

Akinbola, Zekeri and Idowu (2017) [3] examined the influence of government policies on power supply and industrial development in Nigeria using annual time series data from 1981 to 2010. The study adopted the Johansen Co-Integration technique to determine the long run relationship among some macroeconomic variables that included the industrial component of Real Gross Domestic Product. The independent variables included electricity consumption, electricity production (Kwh), growth rate of labour force, real gross fixed capital formation and telephone lines per hundred population and their impact on industrial component of real GDP. The study concluded that electricity condition which was a result of existing government policies exerted a negative impact on industrial output in the long run and affected the business viability.

Kalu (2018) [19] reviewed literature on the impact of deregulation of the Nigerian power sector performance. The study observed that deregulation had the potential to increase power supply in Nigeria. The study believed that when all the power stations granted license by NERC became fully operational, power generation and distribution in Nigeria would improve.

II. Materials and Method.

The study analyzed the performance of Nigerian power sector with the aim of determining the conditions for good performance so as to suggest possible means of ensuring improvements. The study used specification and estimation techniques to analyze the power sector performance in Nigeria for a period of eleven (11) years from 2007 to 2017 which captures the period after major structural changes in the electricity market in Nigeria. The econometric approach for the study relied on time series data regression. Secondary data used were sourced from Central Bank of Nigeria (CBN) Statistical Bulletin of 2018, and Ministry of Power, Nigerian Electricity Regulatory Commission (NERC).

This study measured the change in power generation over time in Nigeria power sector. The geometric mean of each generation index was provided to show the average of the indices. The performance of the power generated was evaluated using the overall efficiency and thermal efficiency as percentages in order to ascertain the actual running periods between 2007 and 2017.

The overall efficiency is given as:

$$Overall\ Efficiency = \frac{Energy\ Generated \times 1000 \times 3600}{\frac{Gas\ Consumed}{35.3147} \times Cv} \times 100\% \quad (1)$$

The thermal efficiency is given as:

$$Thermal\ Efficiency = Overall\ Efficiency \times Generator\ Efficiency \times 100\% \quad (2)$$

$$= Overall\ Eficiency \times 0.98 \quad (3)$$

where;

Generator efficiency is constant at 98%, *Cv* is the calorific value of the gas (usually between 34,000 and 36,000 KJ/m^3).

III. Discussion of Results.

The analysis of results for the efficiencies (thermal and overall) of the power generated for period of eleven years (2007-2017) is presented in Figures 2 to Figure 5.

Figure 2 shows the variation of generated power capacity with the study years. The results show that the least generated power value was 191028 MWh in the year 2007. The highest generated power capacity was in the year 2017 with value of 307200 MWh, this is due to major improvement in power sector by the Federal Government in which the government was investing heavily in expanding the generation capacity.

Figure 3 shows the relationship between the overall efficiency and the study years. The result shows that the overall efficiency of the generated power varies between 12.25% to 16.26% with an average value of 15.68%. The minimum and maximum efficiency is in the year 2007 and in 2008 respectively. This was characterized by forced outages sequel to the fact that efficiency depends on the total output. In addition, due to shortage in gas consumption in 2009, this led to the drastic fall in efficiency between 2008 and 2017. The shortfall from this efficiency level was due to lack of gas supply, lack of maintenance and inadequate skilled manpower.

The variation between the thermal efficiency with the study years is depicted in Figure 4. The result shows that the thermal efficiency of the generated power varies between 12.01% and 15.91% with an average value of 15.37%. The minimum and maximum efficiency is in the year 2007 and in 2008 respectively. The results were characterized by forced outages sequel to the fact that efficiency depends on the total output. In

addition,, due to shortage in gas consumption in 2009, there was a drastic fall in thermal efficiency between 2008 and 2017. The shortfall from this efficiency level was due to lack of gas supply.

The summary of the average of the efficiencies (overall and thermal) for the eleven years period of study is presented in Figure 5. For the eleven years under study (2007-2017), the study revealed that the average overall efficiency was 15.68% which was in line with expected values of 15% - 20% while the thermal efficiency had the average of 15.37%. The international best practice standards are 30% and above for overall efficiency and 45% and above for thermal efficiency respectively. In each of the evaluated parameters, the generation power capacity had lower performance indices than the set standards. A number of reasons were adduced to be responsible for this shortfall performance among which are-.ageing of generator plant components and disruption in gas supply.

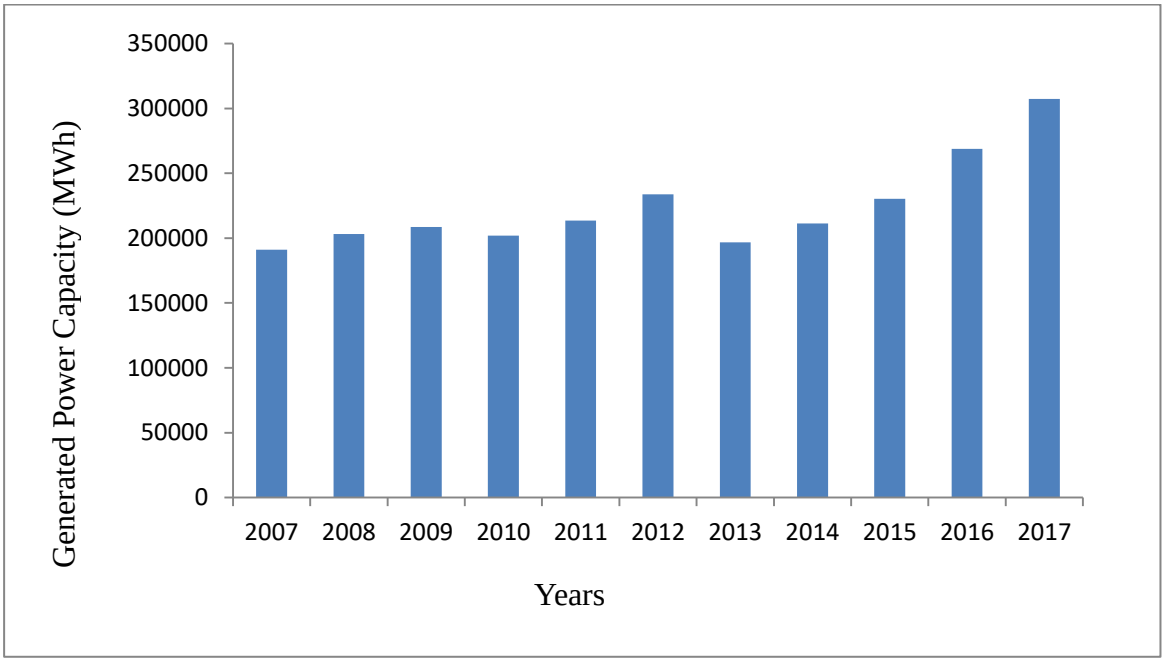

Figure 2: Generated power capacity for period of (2007-2017)

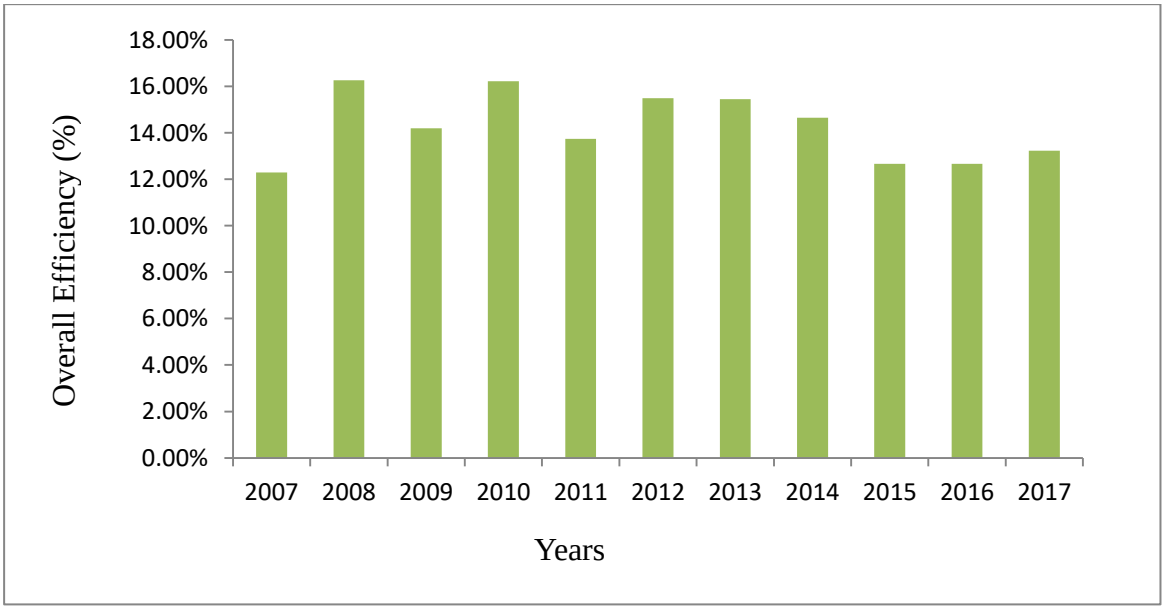

Figure 3: Overall efficiency for period of (2011-2017)

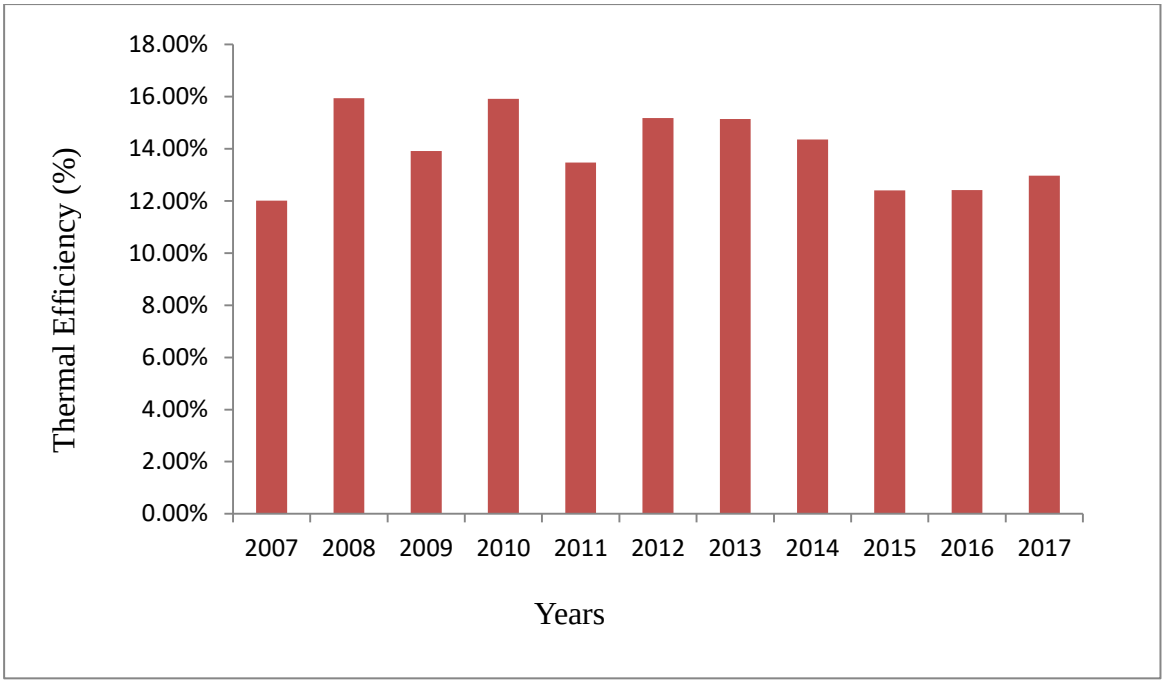

Figure 4: Thermal efficiency for period of (2011-2017)

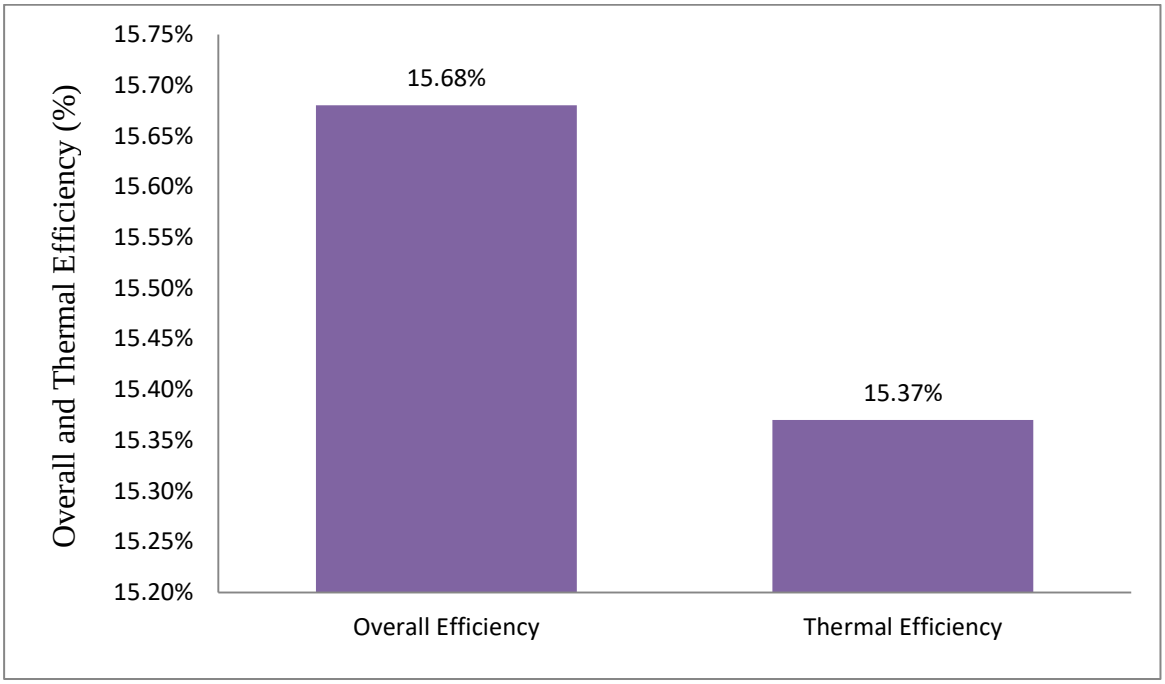

Figure 5: Efficiencies (Overall and Thermal) for period of (2007-2017)

IV. Conclusion

This study has analyzed the performance of Nigeria power sector with the aim of determining the conditions for good performance so as to suggest possible means of ensuring improvements in the country power sector. This was achieved by collecting data from Central Bank of Nigeria (CBN) Statistical Bulletin of 2018, and Ministry of Power, Nigerian Electricity Regulatory Commission (NERC) for a period of eleven (11) years from 2007 to 2017. The data collected were analyzed using the overall efficiency and thermal efficiency calculations.

The results showed that the average value of the overall efficiency for the period of study was 15.68% which was in line with the expected values of 15% - 20% while the thermal efficiency had an average value \of 15.37%. However, the results underperformed when compared with the international best practice standards of 30% and above for overall efficiency and 45% and above for thermal efficiency respectively. In each of the evaluated parameters, the generation power capacity had lower performance indices than the set standards.

The result of this study confirmed that deregulation of power sector did not achieve desired effect on efficiency of the Nigerian power sector. There are still power outages as reflected in the responses from the respondents as electricity power supply can be said to have improved despite the reforms in the last ten years. However, it is imperative that power sector reforms are gradually packing up and it will be a matter of time before development is achieved. The study will assist power policy makers and regulators to come up with better framework for the full realization of Nigeria power sector reform.

V. Recommendations

Power generation reforms in the power sector were meant to improve the power sector, improve the nation's economy as well as the lives of the Nigerian citizens. Based on the results of this study, the following measures are therefore suggested to improve the power sector performance:

i. Government should promote the deregulation and liberalization of electricity production and subsequently approve the applications of the producers in Nigeria because the execution of the reform program with regard to electricity development is too slow for any effective impact.
ii. There is also the need to increase the transmission capacity of the nation.
iii. Having failed to provide electricity even for the present level of industrial production, government should immediately provide tax relief for all privately generated power for industrial output. This will improve the macro economy by effectively checking the excessive production cost which hinders industrial progress in Nigeria.
iv. Plant equipment should be overhauled as at when due.
v. Security of gas supply should be ensured.
vi. Failed plant equipment should be rehabilitated and restored to operation as timely as possible. Obsolete technology should be upgraded.
vii. Operation and Maintenance (O&M) personnel should be periodically trained and re-trained.
viii. Record and data management should be keenly upheld.

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