An Evaluation of the Nigeria Electricity Sector Post Privatization

B. Salman1*, Nm. Hesam2

1 College of Graduate Studies, Universiti Tenaga Nasional, 43000 Selangor, Malaysia.
2 Institute of Sustainable Energy, Universiti Tenaga Nasional, 43000 Selangor, Malaysia.

KEYWORDS

Energy planning
Power sector planning
Nigeria
Electricity generation

ABSTRACT

In Nigeria, the remoteness and erratic patterns of power supply has left especially, the rural population economically and socially below standards. Since electricity is required for the basic developmental of services such as clean piped-water, health care, telecommunications, and quality education. Therefore, the supply predicament has resulted in catalysing poverty among all segments of the population. However, without further doubts attempts have been made by the Nigerian government to reform the electricity sector as an integral component towards the rapid development of the economy. This article provides a clear eyed view on the overall performance of the Nigerian electricity generation post privatization period (2013-15), using a boxplot. The results demonstrated only about 0.56% of capacity was thus far introduced to the grid. Further, the paper finds high correlational in generation pattern and statistically significant barrier to understanding the mechanisms for growth uptick relative to earlier periods. Overall, introducing competition in the power sector does not seem to be effective in stimulating performance expectations. Thus, solving the electricity crisis must remain at the very top of the policy-maker’s agenda. The timely realization of the risks and opportunities of what lie ahead reinforces the idea that Nigeria needs to take aggressively new approach toward putting the energy system on a more secure and sustainable footing.

1. INTRODUCTION

On 1st November, 2013 the Federal Government of Nigeria (FGN) unveiled a milestone in its electricity market reform with the relinquishment of properties to the 6:11 series of new entrants (six generation and eleven distribution companies, while transmission is retained with the government) [1]. All regions and sectors were enthused over the historic event, it pointed to a tranquil future for the nation. Electricity supply is directly proportional to meeting the development model of a country with over 170 million populations and a GDP growth rate of 7%. Studies by [2, 3] advocated that electricity has a unidirectional causality, in other words, poor electricity supply may result in detrimental waves to any economy. Two years later on February 01, 2016 all the excitement ended with the implementation of a forty-five percent increase in electricity tariff. More fascinating, the citizens’ claim there was negligible change in power availability.

Nigeria ranked 116 on the Global Energy Architecture Performance Index, 2015. This implies that, in the context of electricity, Nigeria has one of the lowest per capita consumption in the world. The nation’s highest ever peak generated was 5,074.7MW on February 02, 2016 [4]. On the other hand, demand forecast is beset by the absence of identifying reliable data or source. However, the Ministry of Power put forward demand forecast at 12,800MW in 2015. This reflects supply predicament and thus, must have kept industrial and socio-economic growths below the potential of the economy [1].

This historic deficit has led to widespread use of awful self-generation versions. This scenario has resulted in making Nigeria famous as the world’s largest importer of fossil fuel powered generators and brings about not only environmental impacts, but also an increase in price of goods and services. For example, the biggest telecoms provider is said to operate more than 6,000 diesel powered generator sets across the country with recurrent expenditures of $5.5 million US Dollars monthly [1]. Such significant overhead costs are clearly being passed onto consumers. More so, have played a great part in a downward manufacturing sector, transposed into youth unemployment estimated at about 60 percent [5]. Furthermore, the consumption of one litre of diesel emits around 2.7 kg of CO2 [1].

The absence of reliable energy supply has also left the rural population socially backward, since electricity is...
required for the basic developmental of services such as clean piped-water, health care, telecommunications, and quality education. Fuel-wood is used by over 70% of Nigerians living in the rural areas [6]. Fuelwood, or firewood, consists of any unprocessed woody biomass used to fuel a small fire, most often for cooking or providing warmth. Sourcing fuel wood for domestic and commercial uses is a major cause of deforestation and erosion in Nigeria. The rate of deforestation is about 350,000 ha/year, which is equivalent to 3.6% of the present area of forests and woodlands, whereas reforestation is only at about 10% of the deforestation rate [7].

Indoor inhalation of polycyclic aromatic hydrocarbon (PAH) from cooking appears to pose a substantial health hazard that begin even before birth [8]. Women and children are believed to suffer most from indoor air pollution because they tend to assume the responsibility of cooking and doing housework and spend hours beside fire stoves. Evidence from demographic and health surveys, 2008 shows that Nigeria is faced with the highest risk of neonatal (2088) and child (5148) deaths as a consequence of such events [9]. In addition to affecting public health, soot from biomass burning and other sources, also known as black carbon, is a powerful global warming agent. A study by [10], has suggested that black carbon is the second strongest contributor to global warming after carbon dioxide.

The question that now arises is whether the market reforms can meet up to expectations using a sustainable approach. The objective of this paper is to assess the overall performance of the Nigerian electricity generation schemes during the post privatization period.

2. METHODOLOGY

A descriptive research approach was employed for this study, which aimed to appraise the overall progress of the Nigeria central grid electricity post privatisation periods (2013-15) and at the same time to measure the growth rate, whether it can meet the challenges before it. The best way to begin is to have a philosophical orientation on the structure of the Nigerian electricity generation system. Essentially, the system can be summarised into two which are transmission based on-grid generation and off-grid generation. The on-grid is a strictly hierarchical system with clear demarcations between its generation, transmission and distribution subsystems [11]. This system is regulated by the Nigeria Electricity Regulatory Commission (NERC) and is the focus in this study.

The introduction of market reforms validated the separation of utility business activities that were vertically integrated under a monopoly industry. The 2005 Electric Power Sector Reform (EPSR) act indicated that the state owned entity NEPA which combined generation, transmission and distribution activities to split up to form an almost complete separation of services promoting competition in generation and distribution under a strict regulation and follow-up of regulatory agency, the NERC. Table 1 synthesizes the post-reform retrospective data obtained from the NERC [12].

The Box-and-Whisker plot is an effective parametric regression for visualization and identification of trends in a given distribution. The plot is used to evaluate the steadiness and diverging capability of the dataset in Table 1. It plots the electricity values generated versus the time (months) of generation. The box plots were obtained by classical statistical software – Tableau. The steadiness of the generation is observed by comparing the difference in the optimum values. Smaller difference among the values makes the trend more stable. The top and the bottom of the box are always chosen as

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>83,425.00</td>
<td>2,586,175.00</td>
<td>74,555.00</td>
<td>2,311,205.00</td>
<td>90,571.00</td>
<td>2,807,701.00</td>
</tr>
<tr>
<td>February</td>
<td>81,821.00</td>
<td>2,290,988.00</td>
<td>86,772.00</td>
<td>2,429,616.00</td>
<td>92,011.00</td>
<td>2,576,308.00</td>
</tr>
<tr>
<td>March</td>
<td>80,101.00</td>
<td>2,483,131.00</td>
<td>75,548.00</td>
<td>2,341,988.00</td>
<td>85,165.00</td>
<td>2,640,115.00</td>
</tr>
<tr>
<td>April</td>
<td>74,803.00</td>
<td>2,244,090.00</td>
<td>76,297.00</td>
<td>2,288,910.00</td>
<td>81,437.00</td>
<td>2,443,110.00</td>
</tr>
<tr>
<td>May</td>
<td>60,422.00</td>
<td>1,873,082.00</td>
<td>84,318.00</td>
<td>2,613,858.00</td>
<td>76,804.00</td>
<td>2,380,924.00</td>
</tr>
<tr>
<td>June</td>
<td>80,630.00</td>
<td>2,418,900.00</td>
<td>74,890.00</td>
<td>2,246,700.00</td>
<td>73,652.00</td>
<td>2,209,560.00</td>
</tr>
<tr>
<td>July</td>
<td>89,813.00</td>
<td>2,784,203.00</td>
<td>73,807.00</td>
<td>2,288,017.00</td>
<td>73,011.00</td>
<td>2,263,341.00</td>
</tr>
<tr>
<td>August</td>
<td>93,462.00</td>
<td>2,897,322.00</td>
<td>83,096.00</td>
<td>2,575,976.00</td>
<td>73,697.00</td>
<td>2,284,607.00</td>
</tr>
<tr>
<td>September</td>
<td>94,110.00</td>
<td>2,823,300.00</td>
<td>78,793.00</td>
<td>2,363,790.00</td>
<td>73,488.00</td>
<td>2,204,640.00</td>
</tr>
<tr>
<td>October</td>
<td>91,029.00</td>
<td>2,821,899.00</td>
<td>83,229.00</td>
<td>2,580,099.00</td>
<td>79,189.00</td>
<td>2,454,859.00</td>
</tr>
<tr>
<td>November</td>
<td>95,756.00</td>
<td>2,872,680.00</td>
<td>86,705.00</td>
<td>2,601,150.00</td>
<td>71,830.00</td>
<td>2,154,900.00</td>
</tr>
<tr>
<td>December</td>
<td>91,278.00</td>
<td>2,829,618.00</td>
<td>83,948.00</td>
<td>2,602,388.00</td>
<td>77,427.00</td>
<td>2,400,237.00</td>
</tr>
</tbody>
</table>
the first and third quartiles. The variability of values outside those two quartiles are represented as vertical lines extending from the boxes (whiskers). The two ends of the whiskers in the given plots denotes the lowest datum, which is still included in the 1.5 interquartile range (IQR) of the lower quartile, and the highest datum included in 1.5 IQR of the upper quartile [13]. The horizontal boundary line inside each box, however, indicates the median of the data set.

3. RESULTS AND DISCUSSION

Descriptive statistics are often used to display compendious features of a dataset by summarizing the distribution through a small set of parameters. Usually, these parameters provide insights into the data that would initially be sceptical or hidden [14]. Fundamentally, the descriptive methods involve the calculation of the numerical summary of statistics data such as mean, median, standard deviation and correlation of coefficients [13]. In contrast, the graphical displays portray the classical summary in a visually interpretable way which are used to present the results extensively in this section.

In the traditional univariate boxplot outlier may be defined as any value that lies more than 1.5 times the length of the box from its opposite ends. Outliers may be evidence of a contaminated data set; they may be evidence that a population has a non-normal distribution; or, they may appear in a sample from a normally distributed population. This threshold however can conveniently be decreased in order to increase the probability that the initial clean data set is free from outliers. On the other hand, if the boxplot is considered to have an informal test of the null hypothesis that is the data sample is from a normally-distributed and free from contamination. Hence, a flagged outlier in a properly-distributed sample corresponds to a type I error. But, as we have seen from Fig. 1, there are two outliers in the years 2013 and 2014 corresponding to 8,042,124 MWh and 7,783,637 MWh respectively. Worthy to note that in the context of this study we assume the sample is from a normally-distributed and uncontaminated population thus the existence of a datum mild outlier can never be taken on its own as significant evidence. Also to be noted that data from source had been double checked by an independent party to eliminate human error [15].

Generally, a boxplot gives validating assessment of the location, the dispersion, the skewness, and draws attention to certain potential outliers within a given set of data. Henceforward, the comparative boxplot in Fig.1, is used to evaluate these four features in the Nigeria Grid Electricity Generation Datasets 2013-2015.

1) Assessment of location: The boxplot (Fig. 1) shows that the individual medians increase along the time. In 2015, the increment of median is obviously observed than in the previous years.

2) Assessment of dispersion: The IQR, as shown by the length of the boxes, of year 2013 and 2014 show reasonable similarity in size. Nevertheless, the overall range of the box and whisker plot (including outliers) are in favour of the year 2013. On the other hand, the production in year 2015 shows a much larger IQR variability as compared to its counterparts. In addition, the overall range in 2015 (inclusive of outliers) is widely dispersed enough to fit in the 2013 and 2014 datasets.

Fig. 1. Comparative Boxplots of On-grid Generation 2013-2015

3) Assessment of skewness: In general, the electricity generation in the first two years (2013 & 2014) are appeared to be positively skewed. However, the data in 2013 shows more
skewness and its electricity generation is more pronounced than that of 2014. Contrariwise, generation data in 2015 puts a negative or left-skewed impression. On closer inspection, these skews can be ascribed to the single high outliers and extremist tails across these three years. Although all these distributions vary to some extent in IQR proportions, suggesting some forms of asymmetry of skewness. However, considering [16] suggests mild skewed since data distribution still falls within the acceptable limits of ± 2.

4) Assessment of potential outliers: Observably Figure 1., shows some quarterly outliers in the generation of years 2013 and 2014. These outliers show suspiciously far outlying values that may require keen attention in understanding the qualitative phenomenon behind those generation mechanisms. It could be for example stable natural gas supplies or favourable rainfalls. However, observing closely at recorded generation value in 2015 shows total generation exceeded the outliers in question, thus this could eliminate suspicion on capacity strength. Nonetheless, this could be a potential research area to explore because an in-depth understanding of the causes would help in future strategic planning.

In conclusion, it could be deduced that there are obviously multifaceted problems across the electricity sector in Nigeria. This is evident in the persistent fluctuation in the electricity supply as displayed in Figure 3, of the trend analysis. This would support the attributed challenges highlighted in several literature [17]. More importantly is the fact that there has been no significant addition in capacity to the grid generation system even though the year 2015 looks plausible. A quarterly percentage changes computed showed that overall changes fall within the range of 9.579 (highest in 2015) and 7.345 (lowest in 2015). This clearly depicts that all generations fluctuate within this range and percentage improvement or addition to the grid system never exceeds 2.234% within these periods. In real terms, only 0.56% of capacity was introduced to the grid. Nonetheless, as illustrated in Fig. 2, generation was optimised to some extend in the 3rd and 4th quarters of 2015. This trend of increase supply is not expected to continue from 2015 to 2016 as there have been serious gas supply concerns since the return of Niger-Delta regional disturbance to the gas pipelines network.

According to the World Bank demand forecasts, Nigeria needs a minimum growth in its electricity generation strength by 7% annually for the next two decades to enable energy transition. Overall, the additional installed generation capacity investments required to enable energy transition are significant. This will entail $10 billion of investment across the electricity supply chain to 2020. In addition to $25 billion investment to increase the supply and use of gas across the country.

Estimation reports by the FGN suggested the country requires 40,000 MW of additional installed capacity to meet the various constraints and for sustenance of the wider economic development. However, to grasp the set target would require re-examination of the current market reforms. Elimination of significant amounts of current decentralized gen-set generation capacity. The addition in generation from renewable energy sources (hydro, solar, wind, and geothermal) would need to be substantially increased. Introduce moderate amounts of generations from coal and natural gas - Combine Cycle Gas Turbines (CCGT) however, the potential for Carbon Capture and Storage in the Nigeria context must be inculcated to both generators and regulators. The potential implications on security of supply (especially in dry years in the context of hydro and gas pipes vandalism), increase in the cost of electricity across all sectors, and transmission issues of a renewables scenario all need to be more thoroughly analysed and debated in the public and political arena.

4. CONCLUSIONS

This study extends further the application of boxplot for analysis of the power sector planning in Nigeria. To the best of our knowledge this study presented the first attempt to analyse the electricity generation during post deregulation era. The box-and-whisker design was employed to evaluate the trends and patterns of the grid generation. Based on the study’s observations until date there has been no significant addition (less than 1%) to the central grid in Nigeria. The NERC - agency exclusively responsible for regulating the energy sector needs to improve in terms of data collection procedures, accuracy and sensitivity.

As a result of the under performance of the electricity market deregulation, it is obvious that the Nigeria’s energy supply which has been dominated by diesel powered gen-sets, will continue to soar since population is projected to reach 310 million in 2035. In addition, the economy is projected to recover fast from the 2016 recession and develop as in the past decades. Lastly, thorough energy planning using all its energy wealth must be done to achieve the United Nations Sustainable Development Goals.
ACKNOWLEDGEMENTS

The authors would like to thank University Tenaga Nasional for the research facilities.

REFERENCES


