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Research Article

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The Challenge of Power Losses in Nigeria and their Solutions

Ademusuru, P.O.

Department of Mechanical Engineering, Imo State University, Owerri, Nigeria
E-mail: pademusuru@yahoo.com

Abstract The problem of perennial power outage has remained at the crisis proportion for decades in Nigeria. Almost always the installed energy capacities are not available for use. This study examined the challenge of power losses in the generation, transmission and distribution phases of the electrical energy delivery. An explorative research method was used to access data from already published statistical data. During the period under review (2014-2017), the average capacity utilization is 33.2%, while the average percentage transmission and distribution losses stood at 15.6%; the overall percentage power losses in estimated to be 66.7%. To overcome these challenges, Nigeria must work towards increasing the capacity utilization and reducing the transmission and distribution losses significantly by investing in new and efficient power generation technology. Research and Development, training of technical manpower to handle energy infrastructures, development of indigenous technology in the area of alternative energy sources (renewable) should be given the priority. There must also be a synergy at all level of governance to finance and manage energy sources in Nigeria.

Keywords Power generation, capacity utilization, transmission, distribution losses

1. Introduction

Electrical energy supply is unarguably a major driver of the economy of many nations of the world today. The delivery of clean, affordable and sustainable energy is vital to all aspects of human endeavour. Electricity availability is important from the domestic live and comfort to the productivity of the industries. Energy availability is crucial for economic growth in the world today [1]. The energy crisis that is currently affecting the world is due to both the rapid increase in population and the rise in the standard of living of many societies [2]. Population explosion without corresponding plan and investment in energy infrastructure will obviously result in energy supply shortage.

Nigeria, one of the most populated country in sub – Saharan Africa has an estimated population of about 180 million people and is adversely affected by energy supply shortage. Out of this estimated population, only about 40% are connected to the electrical energy grid. The people who are actually connected experience difficulties around 60% of the time [3]. These blackouts have been adjudged to be responsible for the crippling of the industrial sector in Nigeria.

The Nigeria electricity supply crisis scenario is a complex one stemming from a variety of issues. The energy grid is in crisis owing to lack of development. The current Nigeria electrical transmission line was last upgraded in the 1980s [4]. The current maximum wheeling capacity of the grid is 4,000 MW which is awfully below the required national need [5]. The average electricity demand in Nigeria as at January 2016 is estimated to be 12,800 MW. With the current trend of average generated energy of 3,851 MW, and a wheeling capacity of the national grid standing at 4,000 MW, the target of 20,000 MW, by 2020 seems unachievable. The current distribution infrastructure which are dilapidated and in shambles is making consumers to groan under irregular voltage profile, estimated billings and extortion by distribution companies. The associated cost of revamping and upgrading the distribution network to allow for additional electrical power capacity seem overwhelming to

the distribution companies [4]. The Nigerian energy resources are vulnerable. There is oil and gas pipeline vandalization and theft by the oil producing communities resulting in shortage of fuel to the oil and gas - fired thermal power plants.

The spectator index of the world's worst electricity supply nation in 2017 observed that Nigeria has been ranked as the second worst nation in electricity supply in 2017. Out of the 131 countries examined in the report, Yemen ranked as the worst electricity supply nation, followed by Nigeria, Haiti, Lebanon, and Malawi. Ethiopia occupied 37 position, while South Africa and Algeria occupied 41 and 45 position respectively [6]. This study delved into why Nigeria has not been able to meet her electricity production target. It dwells on how to gradually deal with the shortage of electricity supply with a special focus on reduction in generation, transmission and distribution losses and increased capacity utilization.

2. Overview of the Nigerian Electricity Sector

2.1. The History of Electricity Production in Nigeria

The history of electricity development dates back to 1898 when the Government of the colony of Lagos installed 2 generating sets each with a capacity of 2 KW in Lagos. After the amalgamation of the Northern and Southern protectorate in 1914 to form the modern Nigeria, electricity development grew from small individual undertakings to a relatively larger set up by the local authorities and the central Government through the Public Works Department (PWD).

In 1950, a central body was established by legislation which transferred electricity supply and development to the care of the central body known as the Electricity Corporation of Nigeria (ECN). The Nigerian Electricity Supply Company (NESCO) was also licensed to produce electricity in some locations in Nigeria.

Following the favourable reports that came out of the hydrological surveys of Rivers Niger and Benue, the Niger Dam Authority (NDA) was established by an act of parliament in 1962. The construction of the first dam, the Kainji dam began in March 1964 and was completed in December, 1968 at the cost of N175 million. It was commissioned on the 15 February, 1969. In 1971, Showmount a Canadian firm of consultant were employed to work on the technical details of the merger of ECN and NDA. The report was submitted, and the decree merging the two bodies came into effect on 1 April 1972 with a new name known as National Electric Power Authority (NEPA). By 1992, NEPA has eight major power stations situated at Kainji, Jebba, Shiroro (hydro power stations); Egbin, Sapele (thermal, steam power stations); Afam, Ughelli (named Delta) and Sapele (thermal, gas turbine power station). The total installed capacity is estimated to be 600 mw and there are 74 generating sets with capacity ranging from 10 MW to 220 MW [7-10].

2.2. Current State of Electricity Production in Nigeria

During the advent of the democratic government (1999 – 2005), the Electric Power Sector Reform Act (EPSRAct, 2015), establishing the Power Holding Company of Nigeria (PHCN) was enacted. It was the outcome of an intention to revitalize and privatize the power sector and also to transfer the assets and liabilities of NEPA to PHCN. The bill also brought about the transformation of the PHCN from a single integrated utility into unbundled companies. In 2006, the PHCN was unbundled into six (6) generating companies, one(1) transmission company and eleven (11) distribution companies. Table 1 and 2 show the list of the generation and the distribution companies respectively.

Table 1: Six Existing GenCos in Nigeria, their Names and Installed Capacity

S/NO	Generation Company	Plant Type	Capacity (MW)
1.	Afam Power Plc (i-v)	Thermal	987.2
2.	Egbin Power Plc	Thermal	1,320
3.	Kainji/Jebba Hydro Electric Plc	Hydro	1,330
4.	Sapele Power Plc	Thermal	1.020
5.	Shiroro Hydro Electric Plc	Hydro	600
6.	Ughelli Power Plc	Thermal	942

Table 2: Eleven Existing DisCos in Nigeria and their Percentage Load Allocation

S/NO	Discos	Percentage Load Allocation (%)
1.	Abuja Distribution Company	11.5
2.	Benin Distribution Company	9
3.	Eko Distribution Company	11
4.	Enugu Distribution Company	9
5.	Ibadan Distribution Company	13
6.	Ikeja Distribution Company	15
7.	Jos Distribution Company	5.5
8.	Kaduna Distribution Company	8
9.	Kano Distribution Company	8
10.	Port-Harcourt Distribution Company	11.5
11.	Yola Distribution Company	11.5

There is only one transmission company, the TCN and it is exclusively owned and managed by the Federal Government of Nigeria. The National integrated Power Projects, NIPP was inaugurated in 2004 to catalyze and fast track an increased capacity for electricity production in the country. It was basically a private initiative which is being supervised by the Niger Delta Power Holding Company, NDPHC. Table 3 shows the some NIPP projects and the date of commissioning.

Table 3: 10 NIPPS, capacity and the date commissioned

S/NO	NIPP	Capacity (MW)	Date Commissioned
1.	Alaoji Generating Company Nig. Ltd	1,131	August, 2013
2.	Benin Generation Company Nig. Ltd	508	June, 2014
3.	Calabar Generation Company Nig. Ltd	634	June, 2014
4.	Egboma Generation Company Nig. Ltd	381	June, 2014
5.	Gbaran Generation Company Nig. Ltd	254	June, 2014
6.	Geregu Generation Company Nig. Ltd	506	May, 2013
7.	Ogorode Generation Company Nig. Ltd	508	All units commissioned
8.	Olorunsogo Generation Company Nig. Ltd	754	All units commissioned
9.	Omoku Generation Company Nig. Ltd	265	June, 2014
10.	Omotosho Generation Company Nig. Ltd	513	All units commissioned

3. Methodology

This study employ an explorative research tool for data collection from already published statistical report to analyze the Nigerian electrical power supply scenario from year 2014 to year 2017 with a specific reference to generation, transmission and distribution losses during the period under review. The causative factors for these losses were looked into and analyzed with a view to proffering possible solutions to these problems.

3.1. Energy Generation, Transmission and Distribution Losses

Electricity supply to consumers are delivered in three stages which are generation, transmission and distribution. A major challenge faced by Nigeria Electricity Supply Industry (NESI) are losses in all these phases of electrical energy delivery. These losses include technical and non-technical losses. It has been observed that almost always in Nigeria, a large proportion of electrical energy are lost in the processes of generation, transmission and distribution. The immediate focus of NESI needs to be towards removing or at least reducing this key barrier of losses in generation, transmission and the distribution of electrical power nationwide to the barest minimum.

Table 4 shows the installed capacity, the available capacity and the actual power generated during this period (2014-2017). The average capacity utilization and the average power generation losses were computed shown in Table 5. The value of both transmission and distribution losses for the period under review were shown in Table 6. The capacity utilization was calculated thus;

$$\text{Capacity Utilization} = \frac{\text{Actual generated power (MW)}}{\text{Installed capacity (MW)}}$$

The generation losses were calculated thus;

Power generation losses = Installed capacity – Actual power generated.

Table 4: Installed Capacity, Available capacity, Average power generated (2014-2017) [9-12]

Year	Installed Capacity (MW)	Available Capacity (MW)	Average Actual Power Generated (MW)
2014	10,396.0	6,056	4,000
2015	12,522	3,900	3,600
2016	12,800	7500	4,000
2017	12,500	8000	4,500
Average			4025

Table 5: Capacity Utilization and Percentage Generation Losses (2014-2017) [9-12]

Year	Capacity Utilization (%)	Percentage Generation Losses (%)
2014	34.4	61.5
2015	31.2	71.2
2016	31.2	68.8
2017	35.1	64.9
Average	33.2	66.6

Table 6: Average Transmission and Distribution Losses (2014 – 2017) [9]

Year	Electrical Power Transmission and Distribution Losses (% Output)
2014	15.11
2015	19.0
2016	12.0
2017	N.A
Average	15.6

NA = Not available

4. Discussion

The capacity utilization indicates the actual extent of usage of the installed capacity of generating plants under the period presented in Table 5. The average Nigeria's power generating capacity utilization from 2014 – 2017 is 33.2% as shown in Table 5 with a minimum value of 31.2% recorded in 2015 and 2016 and a maximum value of 35.1% recorded in 2017. These values are very low when compared with other developing nations such as Brazil and India which have relatively higher average capacity utilization rates of 50% and 60% in 2015 [11]. These values are unacceptable as a result of the country's urgent need of power.

Power generation losses are the amount of power which would have been generated but were lost in the generation processes due to either one or a combination of issues relating to location, technology and maintenance. The average power generation losses during the period (2014 – 2017) under review as recorded in Table 5 is 66.6% with a minimum value of 61.5% recorded in 2014 and a maximum value of 71.2% recorded in 2015. This shows that on the average we are left with only 33.4% of the installed capacity baring transmission and distribution losses. This shows a substantial loss in the generation process. Power transmission and distribution losses in Nigeria further reduce generated power output by 16.11% in 2014, 19% in 2015 and 12% in 2016. These losses are further heightened in rural areas where transmission and distribution infrastructures are older.

5. Conclusion and Recommendations

5.1. Conclusion

Despite the reform programmed in the electricity supply industry, the substantial losses in the Nigeria power production value chain are still on the high side as a result of the following factors:

(i) Technology Limitations

Losses in power delivery as a result of technology challenges in Nigeria are very significant and it is responsible for low capacity utilization and consequently generation losses of electricity. The older power plants are equipped with obsolete equipment which employs older technology. This raise challenges when shopping for spare parts for maintenance. Aside this, there is a poor planned maintenance of the generating sets.

(ii) Technical Limitations

The transmission and distribution infrastructures are too old. They were last upgraded in the 1980s. the energy wheeling capacity of the national grid is about 4000mw, while the demand for electricity supply as January, 2016 stood at 12,800 MW. As a result of dilapidated distribution infrastructure the DISCOs too reject some of the energy generated. There is the issue of dilapidated and outdated transmission facilities. There is vandalization of the T & D lines and infrastructure associated with low level of surveillance and security of electrical infrastructure. There is the issue of inadequate technical staff, capacity building and training programme.

(iii) Poor Funding

There is problem of underfunding owing to unavailability of funds. Most of Nigeria's power infrastructure were built in 1970s and 1980s and are presently in serious state of disrepair and are unreliable. The cost of upgrading these infrastructures to allow for additional electrical power capacity are too overwhelming to the generating, transmission and distribution companies. Literatures have revealed that an average cost of US$150 million is required to add an additional 1 MW of electricity to the system. This means Nigeria would have to invest US$150 billion (18 trillion naira) in order to generate additional 100,000 MW to attain what is required for full industrialization of the economy by 2020. This is a phenomenal financial requirement. With this analysis, Nigeria may not be able to meet her electricity supply target without external financial aid. The challenge of social problem of corruption in the country has also resulted in the wastage of available funds.

(iv) Corruption and Sharp Practices

There is a loss of goodwill among the consumers of electricity by the electricity supply industry because of the irregular voltage profile supplied by the distribution companies and the fraud of irregular (estimated) billing system. Many consumers have refused to pay their bills as a result of this and this also has obviously transmitted into poor revenue generating profile of the DISCOs. When governmental agencies refuse to pay their electricity bill, when they have the means to do so, that is corruption.

5.2. Recommendations

(i) Nigeria must work towards improving capacity utilization (currently on an average of 33.2%) significantly by investing is new and efficient power generation technology.

(ii) The transmission losses (15.6% on the average) are quite high. With the country's urgent need of power. A realistic target T&D losses reduction to a single digit should be sought.

(iii) Government should set up more power institutions and as well fund the existing ones in order to give room for Research and Development in the energy sector. This will give room for training of technical personnel who will effectively handle the operation and maintenance of energy infrastructures.

(iv) There should be a synergy between Federal, State, Local Government, private investors and willing consumers to adequately fund the energy sector in Nigeria.

(v) A concerted effort must be made to reduce to the barest minimum or completely eradicate loss of funds meant for energy development through corruption.

(vi) The use of renewable energy technologies should be given accelerated exploitation.

(vii) There must be strong drive to develop indigenous technologies especially in the use of renewable energy.

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