Outage Analysis and System Disturbances on 330 kV and 132 kV Transmission System in Nigeria

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Abstract—The Persistent power outage in the country due to faults has become alarming to the government and the body responsible for electricity generation in the country. It also creates a major problem for electricity consumers in Nigeria, there must be an improvement in the reliability of the transmission system in Nigeria. This research work is predominantly concerned with the analysis of outages on 330kV and 132kV transmission system, and system disturbances on generation and transmission system for five (5) years. The result shows that the forced outages are the most occurred outages on the 330 kV line, while on 132 kV line, emergency outages have the highest number of outages in 2014 but decreases rapidly over the years, similarly, twenty-seven (27) major system disturbances occurred in 2016 with 31% against ten (10) with 11% disturbances in 2015, while 2014 and 2018 with the same number of system disturbances of thirteen (13) with 15%, it is apparent that more disturbances occur on the transmission system, and there should be a proper protection scheme to maintain stable grid network. Consequently, Mini-grid and off-grid solutions will prominently address the issue of power supply shortage and instability in Nigeria.

Index Terms—Disturbances, Generation, Outage, Transmission.

I. INTRODUCTION

The power system performs a very crucial role in the development of a country. Various sectors like health, education, oil and gas, etc. depending on the power system for productivity. Consequently, when there are power system abnormalities, there will be an adverse effect on the activities of various users such as sectors, homes, and industries. And in turn, their productivities are weakened. A power system is said to be in a state of insecurity when a disturbance causes a slow and overwhelming decrease in voltage [3]. Comparably, faults can be known as an abnormal condition, which can occur on the generation system, transmission system or the distribution system, it normally takes some time before the service can be restored despite the huge amount of money being spent [6]. The Nigerian Electricity Regulatory Commission stated that a total system collapse is regarded as a total blackout to the entire nation, while partial system collapse is a failure of a section of the grid [11].

Outages are known as a time when the electricity supply to an area is interrupted due to technical failure [2]. It is imperative that recurrent transmission and distribution system disturbances contribute to the unreliability of the power system. According to [4], [9], thirteen (13) major system disturbances that occurred against twenty-four (24) that occurred in 2017. Twelve with (92.31%) were total system collapses from transmission faults while one with (7.69%) was partial from generation faults. The same 2018, there were 1061 incidences of 330kV outages – comprising forced, planned, urgent and emergency outages. It decreased by 165 (13.45%) compared with the 2017 figure of 1226. In 2018, there were 1914 incidences of 132kV outages. It decreased by 394 (17.07%) in comparison with the 2017 value of 2308. There should be a thorough patrol and maintenance of the circuits to prevent future outage occurrence.

It should be recalled that the tripping of generating station units caused the grid to collapse and most of the faults on transmission lines were transient and can be avoidable if thorough patrol and maintenance of the circuits are implemented. Also, a proper protection scheme will positively improve power supply security. Mini-grid and off-grid solutions will factor prominently in the government’s ability to achieve its energy access goals [1].

II. MATERIALS AND METHODS

The method used in this research involves data collection and analysis from several power regulatory bodies and reviews of related literature. The data comprises of system disturbances data for a period of five (5) years (2014 - 2018) on generation and transmission system, and the respective cumulative data for forced, planned, urgent and emergency outages for a period of five (5) years (2014 - 2018) for 330 kV and 132 kV line.

| Year | Forced Outage | Planned Outage | Urgent Outage | Emergency Outage | Total Outages |
|------|---------------|----------------|---------------|-----------------|---------------|
| 2014 | 651           | 91             | 181           | 106             | 1029          |
| 2015 | 613           | 194            | 132           | 61              | 1000          |
| 2016 | 771           | 160            | 236           | 98              | 1265          |
| 2017 | 801           | 206            | 202           | 17              | 1226          |
| 2018 | 658           | 186            | 206           | 11              | 1061          |

| Year | Forced Outage | Planned Outage | Urgent Outage | Emergency Outage | Total Outages |
|------|---------------|----------------|---------------|-----------------|---------------|
| 2014 | 1070          | 113            | 315           | 2871            | 4369          |
| 2015 | 1048          | 167            | 304           | 1686            | 3205          |
| 2016 | 1116          | 227            | 284           | 1522            | 3149          |
| 2017 | 1061          | 224            | 293           | 730             | 2808          |
| 2018 | 1023          | 309            | 214           | 368             | 1914          |

Published on January 28, 2020.
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DOI: http://dx.doi.org/10.24018/ejers.2020.5.1.1722
**TABLE III: SYSTEM DISTURBANCES ON GENERATION AND TRANSMISSION SYSTEM (2014 - 2018)**[9]

| Year | Total Number of Disturbance | Disturbances caused by Generation Fault | Disturbances caused by Transmission Fault |
|------|------------------------------|----------------------------------------|------------------------------------------|
|      | Actual Number | % of Total | Actual Number | % of Total |
| 2014 | 13             | 2          | 10           | 76.92%     |
| 2015 | 10             | 0          | 10           | 100.00%    |
| 2016 | 27             | 8          | 19           | 70.37%     |
| 2017 | 24             | 4          | 20           | 83.33%     |
| 2018 | 13             | 1          | 12           | 92.31%     |

Table III shows the system disturbances on Generation and transmission system for a period of five years. In 2014, the total number of system disturbances is 13, 10 with (76.92%) from transmission fault while 2 from generation fault with 15.38% and one is total collapse due to indeterminate causes with 7.69% which is not captured in the table.

**III. RESULTS AND DISCUSSION**

Fig 1. Chart showing Cumulative Outages on 330 kV lines (2014 - 2018)

Fig 1. shows that forced outages have been the most occurred outages on the 330 kV transmission line with the highest outage while the emergency outage with the lowest.

Fig 2. Chart showing Cumulative Outages on 132 kV lines (2014 - 2018)

In 2014, emergency outages have the highest outage of 2871 which is far greater to all other outages when added together in that year as shown in Fig. 2.

Fig 3. Chart showing Cumulative Outages on 330 kV and 132 kV lines (2014 - 2018)

It could be seen that there is a minimal variation in the cumulative outages on 330 kV lines, this implies that more fault occurs on the 330 kV transmission system with a rapid decrease in the outages. Fig. 4. shows that twenty-seven (27) major system disturbances occurred in 2016 with 31% against 2015 with the lowest disturbance of ten (10) which amount to 11%, while 2014 and 2018 have the same number of system disturbances of thirteen (13) with 15%, it is evident that more disturbances occur on the transmission system.

**IV. CONCLUSION**

This paper presented the outages and system disturbances experience in the generation and transmission system in Nigeria. The result shows that the forced outages are the most occurred outages on the 330 kV line, while on 132 kV line, emergency outages have the highest number of outages in 2014 but decreases rapidly over the years, similarly, twenty-seven (27) major system disturbances occurred in 2016 with 31% against ten (10) with 11% disturbances in 2015, while 2014 and 2018 have the same number of system disturbances of thirteen (13) with 15%, it is evident that more disturbances occur on the transmission system. it has been observed over the years that most outages and system disturbance is due to unreliable protection schemes, aged equipment, poor relay coordination which contributed immensely to a great amount of power loss and instability in the grid, there should be a proper protection scheme to maintain stable grid network. Consequently, Mini-grid and off-grid solutions will prominently address the issue of a power supply shortage in Nigeria.

DOI: [http://dx.doi.org/10.24018/ejers.2020.5.1.1722](http://dx.doi.org/10.24018/ejers.2020.5.1.1722)
V. RECOMMENDATIONS

From the results of the analysis, the following recommendations are made:

1) Need for urgent rehabilitation of most turbine governors of the generating units to improve their effectiveness.
2) NIPP and IPP power stations should be encouraged to participate in frequency regulation and spinning reserve to maintain a stable grid network [5], [9].
3) All generators in the grid should be on Automatic governor control.
4) Procurement of spinning reserves and effective under frequency relay systems should be put in place to take care of the tripping of units.
5) Thorough patrol and maintenance of the circuits should be implemented.
6) Routine check for bird nest construction and remove during regular maintenance [10].
7) Mini-grid and off-grid solutions should be embraced to factor prominently in the government's ability to achieve its energy access goals.
8) Routine system studies must be carried out to discover any problem in the network.

REFERENCES

[1] ADP, African Development Bank: “Nigeria Electrification Project Appraisal Report, PESR/ PERN/ RDG,” November, 2018.
[2] Fichtner, “Transmission Expansion Plan Development of Power System Master Plan for the Transmission Company of Nigeria,” Nigeria Electricity and Gas Improvement Project, 2017.
[3] Ogbuefi, U. C., Ugwu, C. L., and Ogbogu, N. O, “Analysis of Nigeria Power System Voltage Collapse Incidences from 2000 To 2017,” IOSR Journal of Electrical and Electronics Engineering, Vol. 13, Issue 2 Ver. I, Pp 28-34, April 2018.
[4] Okoye, C. U. and Omolola, S. A. “A Study and Evaluation of Power Outages on 132 KV Transmission Network in Nigeria for Grid Security,” The International Journal of Engineering and Science (IJES), 8.11, Pp 53-57, November 2019.
[5] Okoye, C. U., Omolola, S. A., Adelakun, N. O. and Bitrus, I, “Retooling Nigeria’s Electricity Generation Sub – System for Sustainable Grid Operation,” International Journal of Innovations in Engineering Research and Technology, Vol 6, Issue 12, Pp 7 – 13, December 2019.
[6] Oputa, O. and Madueme, T. C, “Fault Analysis On Nigeria 330KV Transmission System Using ETAP,” Nigerian Journal of Technology (NIJOTECH), Vol. 38, No. 1, Pp. 202 – 211, January 2019.
[7] TCN, Transmission Company of Nigeria: “Grid System Operations, Annual Technical Report,” National Control Centre, Osogbo, Nigeria, 2015.
[8] TCN, Transmission Company of Nigeria: “Grid System Operations, Annual Technical Report,” National Control Centre, Osogbo, Nigeria, 2017.
[9] TCN, Transmission Company of Nigeria: “Grid System Operations, Annual Technical Report,” National Control Centre, Osogbo, Nigeria, 2018.
[10] TCN-PMU, “Environmental and Social Impact Assessment (ESIA) For the Proposed 132/33kV Transmission Substation at Kabba, Kogi State,” Transmission Company of Nigeria - Project Management Unit (TCN-PMU), March 2016.
[11] Timileyin, O., “Blackout as power grid collapse three times in 18 hours,” The Guardian Newspaper, Thursday, May 9, 2019.