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# Electrical Power outage in Nigeria: History, causes and possible solutions

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**Abstract**
Power outages have assumed a very high embarrassing dimension in Nigeria. There are several areas of national life that power outage should never rear its ugly head but alas in Nigeria power outage for several days is common and could happen just anywhere – In 2009, the presidential palace was not spared and power outage became so frequent that ever since, the state house is powered 24 hours with generators. The last Junior World cup played in Nigeria really brought out some embarrassing moments when the whole pitch was thrown in darkness. The Muritala Mohammed Airport is not spared despite being the main gateway in the south into and out of this country. In the midst of this however, Nigeria's demand for energy and electricity is increasing rapidly and Nigeria has a 20 - 2020 vision (i.e. to become one of the twenty industrialized countries by year 2020). This paper covers 120 substations in Ondo State of Nigeria that can be described as fairly industrialised and well populated. The information available from these stations helps to describe a general situation facing the country as a whole. This article presents some solutions to these embarrassing moments. It is a paper designed to highlight some steps that can help achieve stable power supply in Nigeria.
**Keywords** Energy utilization; Power outages; substations, energy management and Nigeria.

## 1.0 Introduction

Electricity plays a vital role in modern society. It is about the greatest invention of man. A country becomes a 24 hours society because of the level of power (Electricity available). Nigeria needs to get to that level so that we can begin to move into the league of developed nations.

There is no excuse for power failure because it is possible to have uninterrupted power supply as we have in several countries in the world (both developed and developing).

The Nigeria power sector operates well below its estimated capacity with power outage being a frequent occurrence. According to Power Holding Company Nigeria (PCHN), the country peak electric demand three years ago was 7,600 megawatt (MW) but the actual generation capacity was 3,600 megawatt (MW).

The discrepancy between electricity demand and actual generation is mostly due to low water levels, unavailability of gas to power the turbines and the inadequate plant maintenances that pervades every PHCN installations all over the country. Presently electricity generation capacity fluctuates between 2,600MW and 3,600 MW.

Despite the fact that this level of power generation might be grossly inadequate for a country of the size of Nigeria, one of the major problems facing the present situation and which will affect any future development is the distribution of the final sub-circuit from 11,000/400 volt system that have proved more challenging (in my overall assessment). It is very challenging in that almost 35% (if not more) of the power available at this level/point is lost due to wastage.

Most substation and electrical networks in Nigeria were established in the 50's and 60's. These networks with some upgrading are still functional till today with its attendant poor performance and epileptic power delivery, which has now become the headache of Power Holding Plc (PHCN).

The aim of this paper is to address this level of poor power supply with the aim of improving it to an optimal level that will help industries and other domestic facilities to operate efficiently and effectively.

A. Cost of power

The cost of power loss should not only be seen as the initial cost of outlay and installation but the cost of lost businesses and revenue accruing to government and individuals.

B. Wastage of power generated through distribution

In this paper, discussions will emphasis the improvement that can be achieved from the area of distribution (11KV/415V) because the wastage occurring through distribution is enormous. The distribution system is particularly important to an electrical utility for two reasons:

It's close proximity to the ultimate customer and

Its high investment to the customer,

C. Power at Substation

Wastage in this area can be categorized as follows:-

- Poor general maintenance on transformers, termination points etc at the substation bus-bars, etc.
- Using underrated cables which result in massive voltage drops at almost every termination to buildings and industries thereby causing unnecessary loss of power/voltage at customers' power distribution point. Several 35 $mm^2$ cables have been stripped to about 16 $mm^2$ in several places to distribute power to the residents. Measurements carried out always give a low voltage drop of more than 40%. The voltages at most of these areas are between 120 and 175V as compared with 160 to 200V in areas with proper cabling sizes.
- Under rated fuse. Except for few bus bars, more that 80% of the fused bars were grossly underrated as fuses that were used are not rated fuses but bare copper wire wound round the former fuses.
- Switchgears - proper maintenance on these were poor.
- Under rated transformer 80% of substation visited have transformer that are lower in ratings to what they are supposed to be as most of them were installed several years back when the energy demand of that area was still very low.
- Lack of maintenances. These observations were shocking. Even in areas where the maintenance were done, they were not detailed enough. There is no PPM of any kind on any of the substation visited. The maintenance was only based on whenever there is problem. An example was in March 2012 when for upward of 2 weeks, 80% of Ondo state were in darkness because the national grid center in Oshogbo went down and parts for replacement of burnt parts had to be ordered from abroad before power was restored to affected areas of Ondo state after 2 weeks.
- Environmental factors Such as: - impact on ratings, noise pollution, flood risk, insulation, corrosion, and vandalism which are now the hallmark of Power Holding Company Nigeria (PHCN).

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**D. Distribution section**

**Some unacceptable methods that lead to wastage are as follows:**

- Usage of bare cables to terminate a connection from the pole to the building
- Most residential flat or bungalows observed were served with more than a single phase as supply.
- Substation bus bars should be made to carry load that cannot be protected by the rated fuse
- The usage of copper wires as fuse on bus bars has helped to worsen the situation and caused a lot of damage to installed equipment. The copper wire so used will just be wound across the fuse without any recourse to the standard type of fuse to be used.
- Attitude of workers, which is at its lowest web nowadays, is not helping matters. The issue of privatisation (expected in October 2012) is confusing to many of them. References were to NITEL (Nigerian Telecommunication Ltd) that went through the same privatisation that led to a lot of hardship to their former workers.
- Incessant load increase should be stopped. Several loads have overshot the load forecast of most substations. Most of the substations visited were installed over 25 years ago and most of them have not been upgraded ever since and the load however has increased by more that 40% going by the available data from PHCN.
- Presently, connections of any building to the electricity network are not certified. This should be stopped forthwith. The electrical wiring of any building should first be ascertained and certified by an authorised person that can be held responsible in the future in the situation where there is avoidable problem. No building should be connected to the electricity network until they are certified
- If overload situations are repeated too frequently, this affect the operation of the transformers which result in excess current within the transformer termination, which lead to losses that affects the peak power demand on each transformer.

**E Some solutions**

- Introduction of ring circuit where it is required. We intend to have it on both the 11KV and 415V network
- Standby generation plant (Peak Lopping co-generation) to support the network during the peak maximum demand by exporting back to the grid. This is meant to assist the system in extremely essential areas like in the hospitals, essential government buildings, light railway system being considered in Abuja and Lagos state and some other designated essential areas. Whenever there is an outage, these areas would be supported by standby MW generators that can withstand sudden load until power is restored. This practice is now being practised in Akure street lighting systems and Lagos.

- Solar Power for the street lighting as standalone system, which reduces the maximum demand during peak period. This will help to restore several mega-watts of power back to the electricity system without compromising the security of the nation.
- The sizes of cables to be installed must be designed to overcome whatever volt drop per metre run presently experienced on the electricity network in Nigeria. The cable rating will also be based on calculations fault level, power consumption of each installation etc and not a blanket sizes for residential building like we have presently.
- Correct ratings of switchgears fuses and circuit breakers must be used every time. A system that ensures this must be maintained.
- New sub-station location shall take into account access and environment factors such as; impact on rating, noise pollution flood risk, insulation and corrosion.
- A system that ensures that maintenance can be carried out without interruption to supply should be worked out by ensuring a N + 1 system is put in place in the country. (i.e. a system whereby if there are outages, there are adequate back-up system that will be deployed almost immediately).
- Maximum protective short-circuit current at the supply terminals.
- Suitable sizing of devices should be ensured every time.
- The type of earthing system applicable to the connection end must always be in accordance with the IEE regulation.
- Power factor, frequency, voltage and number of phase's information must be kept and used whenever there is a need for expansion and new installations.
- Protection settings determined on the base of fault-current calculations.
- Peak maximum demand consumption should be used mainly to determine the fuses, circuit breakers of any installation.
- Like we have in advanced countries, there must be an approved Electricity Regulation and installation manuals that must be used at all times on all installations and electrical materials.
- Development of an Energy Management System for the country. This will help the country to understand what we have now and help us to lay a solid foundation for energy movement in the country. This Energy Management System will be a calculated energy system that can be verified and manipulated at every stage to achieve the aim of arming this country with enough energy to make them a player in world economy by 2020. It will be a prototype that can be used anywhere in the country.
- Sustainable maintenance program should be enacted as part of the Energy Management.
- Effective control network (HV/LV system) (both on automatic and also manual) should be developed. The gradual phasing out of manual closing of circuit breakers should begin forthwith. Presently in the advance countries what we is called step loading which loads up a transformer gradually immediately after a fault. This is because transformers are subjected to many external electrical stresses from both upstream and downstream. The consequences of any failure can be very great in terms of damage as well as in terms of operating losses so re-loading should be gradual.

**F System Overview and Maintenance as part of the Energy Management system**

The primary mission of electrical maintenance is to keep the electrical installation up and running.
There are two type of servicing
Corrective action following an operating fault
Periodic Preventive action (PPM)
Information to be kept whenever there is outage from any of the substations should include the following.

(i) Type, design, manufacturer and other description for purposes self classification
(ii) Date of installation, location on system, length in the case of line
(iii) Mode of failure (short-circuit, mal-operation, etc)
(iv) Cause of failure (lightning, tree, etc)
(v) Times (both out of service and back in service rather than outage duration alone). Date, meteorological conditions when the failure occurred
(vi) Type of the outage, forced or scheduled, transient or permanent.

**G From the observation in Nigeria, the following suggestion will be relevant:-**

1 Creation of electrical zones. These must be made into a low voltage ring system. The zones are equipped with a distribution bus bar. These distribution bus bars are fed from one or two large transformer to cover a town, city or a large zone. The cabling must be adequate (at least 100 $mm^2$ armoured cable for domestic houses) To ensure effective load distribution and ensure balanced power, it will be the duty of PHCN staff that allocate line and every house power demand must be calculated to justify more than single phase

supply. More areas can be connected and isolated in cases of faults within the zone. Easy localization of fault will be possible. This method will also help in several areas where incessant, unplanned expansion is rampant.

2. This paper will strongly recommend system maintenance, which should include inspection, specific PHCN designed preventive maintenance methodology and general overhaul of defective systems. The inspection should be on schedule or off scheduled. Well-managed maintenance practices should result in fewer forced outages; win consumer goodwill and lower maintenance costs/kWh of the energy supply. All inspection must be certificated and higher or independent body will reconfirm a percentage of these.
3. There should be training and retraining of PHCN staff. This is an area where there is a need for urgent attention. The majority of staff attitude are at its lowest web nowadays. This is not helping matters. Staff must be trained to know what to deliver. There must be training up to at least the level of a diploma in areas like Inspection and testing, Erection and testing, Installation etc. Some of the staffs are trained on the job without any background knowledge of electricity – this is not healthy.
4. The infrastructure for good maintenance should provide requisite technical training to linemen, line supervisors, and operators; suitable maintenance and operating manuals; tools kits and maintenance materials. The successful implementation of maintenance should be based on the following consideration.
5. The network system should be well planned, properly erected with good quality material and well-trained and adequately equipped maintenance staff.
6. Newly erected lines must be inspected thoroughly after rains during the first year of their service.
   The minor defects noticed during inspection should be rectified at the time of the inspection itself wherever possible, and the other defects at the earliest possible occasion after chalking out a programmed in advance.
7. In case of the occurrence of any abnormal situation, the equipment should be immediately disconnected from service and the matter reported to higher authorities for further instructions.
8. Manufacturer's instructions should always be given due consideration while carrying out the maintenance of a particular equipment.
9. A correct record of all test results and inspections should be maintained. Lines having more tripping, villages having more electrical complaints, areas where distribution transformers are repeated damage, should be thoroughly inspected and emergency maintenance be done.
10. For most of the ageing equipment such as power transformers, cables, lighting arresters, etc. diagnostic age analysis is necessary to undertake special or emergency repairs, replacement, modernization, renovation, recondition programmed.
11. Required safety precautions must be observed while carrying out any maintenance works.
    The present schedules once should be subjected to periodical review in the light of previous experience to see if improvements are possible, not only to ensure adequate maintenance but also to reduce cost. However, alterations should not be made frequently; otherwise it may not be possible to obtain any correlation between the cost and performance.

12 Maintenance of transformers and its local distribution system should be carried out together, to ensure a healthy system

13 Fast attendance of consumers' electricity complaints will help improve goodwill and image. The advent of GSM will help quick attendance to faults. Infrared Thermal Imaging. Infrared thermal imaging is based on the principle that, all objects emit electromagnetic thermal radiation. Normally invisible to the naked eye, this radiation can be detected using an infrared scanning camera, which converts the thermal energy into electronic video signals. By amplifying these signals, it is then possible to view thermal images of the object on a display screen. This will help to determine the system(s) that is (are) over loaded and hence overheating.

**13** The transmission lines between each towns should be replaced with underground cabling system to avoid the present unacceptable level of outage due mainly to adverse weather (storm and rain)

 

**Table 1.1 Analysis of consumer complaints, PHCN Central Office (Ondo State)**

***Period between January and June 2011***

| S/N | Transformer Fault Nos | Frequency | Consumers on the transformer |
|---|---|---|---|
| 1 | 200KVA Otapete (Owo) Neutral link looses contact and short circuit on transformer | 3 per week | 150 bungalows |
| 2. | 100 kVA (St Catherine Junction) H.T Fuse blown | twice daily | over 270 houses |
| 3. | Tee joint loose 100 kVA Uka junction | 14 week (about five streets) | 132 houses |
| 4. | Tee joint loose HT Fuse blown LT fuse blown 200 kVA (Iselu) | several times (over 8 times weekly) | 10 major streets |
| 5. | LT jumper burnt HT fuse blown 100 kVA (Okedogbon) | 11per week | 15 streets |
| 6. | HT jumper blown LT fuse blown 500 KVA (Iyere) | 2 per week | a medium community |
| 7. | Meter terminal burnt, HT fuse blown Service line burnt 200 KVA (Isuada) | 1 within a month | a medium community |

**NOTE**

| | | |
|---|---|---|
| The main station7.5MVA | average of thrice weekly since the beginning of raining season (April) | The whole town |

## H. Conclusions

Any country with poor level of power availability like Nigeria should first of all think about improvement of generation and distribution before thinking of industrialisation. 20 (2020) is a mirage like all other dates that have been mentioned in the past that has gone without any significant effort of achieving the set targets.

The above observation and projections coupled with the Prototype Energy Management system will ensure that more energy are available for the industrial sector while efficiency will become the watchword.

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