

Reliable and Efficient Power Supply in Nigeria through National Integrated Power Projects and Independent Power Projects: A Case Study of Onitsha Metropolis

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ABSTRACT

Nigeria is presently faced with the challenge of providing sustainable, adequate, reliable, and efficient electricity supply to Nigerians. This has adversely affected the social and economic life of the whooping 150 million Nigerians. The abysmal and epileptic nature of electric supply in the country in general and Onitsha Metropolis in particular is becoming very unpalatable hence the recourse to National Integrated Power Projects (NIPP) and Independent Power Projects (IPP). To improve on this ugly situation, apart from generating enough quantity of power, the electricity delivery system ranging from transmission to distribution, must have robust and flexible networks always to satisfy the Nation's demand for electricity. This paper therefore is devoted to the assessment of the effect of NIPP/IPP projects so far on the supply of electricity in Onitsha Metropolis. The work revealed a 25.2% improvement in the percentage availability (%AV) of supply, reduction in outages and faults due to load shedding and load limitation by 10.7% and 7.06% respectively.

Key Words: Faults, NIPP/IPP projects, percentage availability, load limitation, power supply.

1.0 INTRODUCTION

Electricity plays vital role in the socio-economic development of a nation [1]. Generally, electricity is accepted to mean supply of electric power. This involves generation, transmission and distribution of the electric power to consumers. Electricity is an aspect of the utility sector that is very essential to the smooth and meaningful development of a society. It supports the economy and promotes the well-being of individuals. Efficient functioning of this utility is of paramount importance for the sustenance of its growth and consequential realization of its planning and managerial objectives. It has been the intention of the Federal Government of Nigeria to improve on the quality of power in the country. Several public embarrassments have been recorded in the country due to power failure or outage. In April 2012, there was total power outage in Muritala Mohammed International Airport [2], what a national embarrassment.

In March 2000, two power system collapses within a three-day interval plunged the country into darkness. The nation was without electricity for up to 72 hours in some areas with serious social, economic and security implications. Consequently, the government in her earnest efforts to reform

power supply in the country sacked the power utility (NEPA) board and appointed a Technical Board to oversee the day to day activities of the Authority [3]. President Obasanjo worked very hard to see to the realization of steady power supply by the end of 2001 in the country. He made this clear when he gave a mandate to the National Electric Power Authority (NEPA) to ensure uninterrupted power supply to the nation by 31st December 2001[4]. It was noted that NEPA that period, raised electricity output from as low as 1,600 megawatts to 4,000 megawatts and over one billion dollars spent in order to meet up with the mandate [5]. Not quite some time, despite the seriousness of the Government towards this noble idea, the quality of power kept sinking every day. Erratic power supply and outages remain a major problem confronting the nation despite the huge amount of money being spent in improving the power system, hence, in March 2005; President Olusegun Obasanjo signed the Power Sector Reform Bill into law, enabling private companies to participate in electricity generation, transmission, and distribution. Nigerian government also made an effort to increase foreign participation in the electric power sector by commissioning Independent Power Projects (IPPs), National Integrated Power Project (NIPP) to generate/improve electricity and sell it to PHCN all in the direction of power reform.

2.0 NEED FOR POWER REFORM IN NIGERIA

The decay in the quality of power in Nigeria reached an alarming stage that the Nigerian power sector was characterized with the following problems [6]:

1. Inadequate power generation capacity
2. Inefficient usage of capacity
3. Lack of capital for investment
4. Inefficient regulation
5. High technical losses and Vandalism
6. Insufficient transmission and distribution facilities
7. Insufficient use of electricity by consumers
8. Inappropriate industry and market structure.

In the face of all these problems, the federal government under President Obasanjo set the winding of PHCN to commence on July 1, 2006, and the successor companies were supposed to become autonomous same July 1, 2006 in accordance with Power Sector Reform Act of 2005.

3.0 NATIONAL INTEGRATED POWER PROJECTS AND INDEPENDENT POWER PROJECTS POWER STATIONS:

Under NIPP/IPP, several power stations were awarded to be constructed and the status of each till date is shown in table 1. All these power stations are gas-powered plants and this could be attributed the abundant gas reserve of the Nation. The plants are all sited in the Niger Delta area very close to the oil wells though they are far away from the load centers, the Federal government is investing massively in provision of transmission lines and sub-stations to evacuate or wheel generated power optimally to the respective load centers at Lagos, Kano, Onitsha, Kaduna, Maiduguri, etc.

Table 1: NIPP/IPP Power Stations.

S/ N	Power Station	Installed Capacity	Status	Year of Completio
1	Alaoji Ps	1074 MW	Partially Operational	2009/2010
2	Calabar Ps	561 MW	Under Construction	
3	Egbema Ps	338 MW	Under Construction	
4	Geregu II Ps	434MW	Partially Operational	2012
5	Ibom Ps	190MW	Partially Operational	2009
6	Ihovbor Ps	450MW	Under Construction	
7	Olorunsogo II Ps	675MW	Partially Operational	2012

8	Omosho II Ps	450MW	Partially Operational	2012
9	Sapele Ps	450MW	Operational	2012
10	Omoku II Ps	225MW	Under Construction	
11	Okpai Ps	480MW	Operational	2005
12	Afam VI Ps	624MW	Operational	2009/2010
13	Afam IV – V Ps	726MW	Partially Operational	1982 and 2002
14	Aba Ps	140MW	Under Construction	
15	AES Barge	270MW	Operational	2001

Source: [7].

4.0 ELECTRICITY SUPPLY TO ONITSHA METROPOLIS

In Nigeria, electricity is generated at different voltage levels at different power stations - Generation. Generator transformers are used to step up the generated voltage to higher voltage levels (330kV or 132kV) to be transmitted over long distances using transmission lines - Transmission. The transmitted high voltages (330kV and 132kV) are stepped down to lower voltage levels (132kV, 66kV, 33kV, 11kV and 415/240V) at various transmission stations and sub-stations - Distribution.

It is of utmost importance to ensure the most continuous production and transmission of adequate power at satisfactory voltage levels as possible with available tools and equipment with due consideration to the security of the grid system and observance of operating limit of installed equipment apparatus.

4.1 GENERATION/TRANSMISSION:

The supply coming from Benin, Alaoji or Okpai generating stations may come simultaneously or concurrently and feeds into the transformers. Fig 2 shows a single line circuit diagram of Onitsha 330kV network.

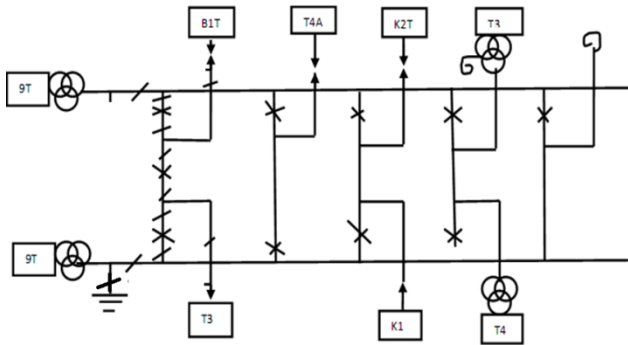


Fig 1: A single line Circuit diagram of 330kV of Onitsha work Center.

Transmission lines receive energy from generating stations, provide equal access for power evacuation to all participants at all times, and ensure full evacuation capability and reliability at minimum technical loss. They are also to ensure equitable load allocation to consumers via its distribution substations. This energy from generating stations is moved down through a 330kV transmission line to a transmission station into a 2 x 90MVA (9T1 and 9T2) and a 2 x 150MVA (T3 and T4) step down transformers (330kV/132kV). These four power transformers are fed into two main buses; Bus bar 1 and Bus bar 2. (See Figure 1)

Energy at this level is controlled by a 330kV control room/switch yard, a place where switching, interchanging, direction and redirection of this energy is done using breakers and isolators.

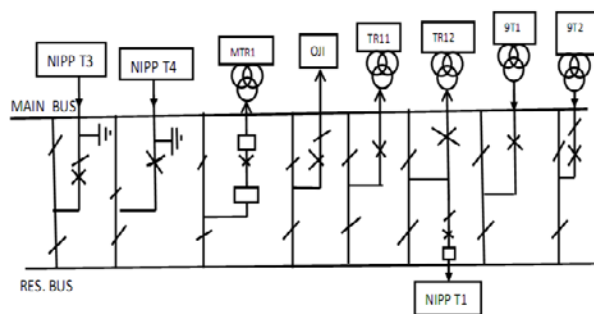


Figure 2: A single line Circuit diagram of 132kV of Onitsha work Centre.

Within the transmission station, another 132kV/33kV transformer steps the energy to 33kV. Also a 132kV control room/ switch yard controls this level of voltage. This is the second part of transmission station. The energy at this level is fed into 45MVA (MTR1), 2 x 60MVA (TR11 and TR13), 15MVA (TR12), 40MVA (MTR2) transformers. These transformers are 132kV/33kV step down transformers and their 33kV sides feed distribution stations. (See Figure 2).

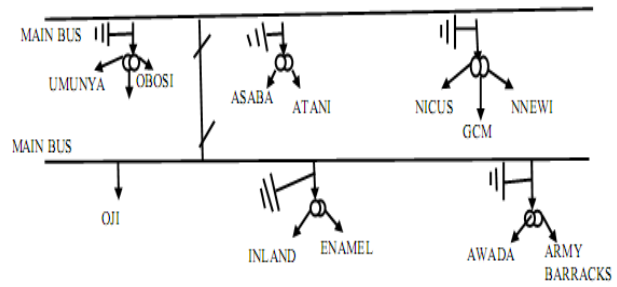


Fig 3: 33kV Circuit Network.

5.0 THE STUDY AREA

Onitsha metropolis is situated within the coordinates of $6^{\circ} 10' N$ $6^{\circ} 47' E$ the largest city in Anambra state in Nigeria. It occupies a land area of about 36.19km² with a projected population of between 561,106 and 1,000,000 [8]. Onitsha has two major tertiary institutions namely, National Metallurgical Institute (NMTI), Blessed Iwene Tansi Senior Seminary. It also has a general hospital, many industries, water board, army barrack, and houses the largest market in West Africa – Onitsha Main market and six other big markets.

Onitsha is the second largest industrial area in Anambra state and the largest commercial area in the entire South East of Nigeria. Onitsha serves as the gateway between south-eastern and south-western Nigeria. This area sits where a high ground underlain by the sandstones and comes very close to River Niger. It provides a stretch of well-drained, healthy site in the flood plains of the River Niger. Such favourable site at the meeting point of two contrasting regions east and west of the Nigeria, which provides a link with the savannah zone to the north and the forest and delta region to the south, enabled the area to develop as an important commercial centre, south east of Nigeria.

The area is heavily populated resulting in high electricity consumption. These commercial and industrial activities are carried out with stable, reliable and dependable electricity. To achieve effective power supply in the country and to attract investment in the power sector, Nigeria national Petroleum Cooperation (NNPC) called for the pursuit of the Public-Private Partnership (PPP) [9]. The epileptic nature of the electric supply, the constant load shedding and the inconsistent supply are attributable to insufficient facilities or corridors for evacuation of generated power to the consumers. This unhealthy situation has necessitated this study to show the effect of the NIPP and IPP projects on the power supply improvement in Onitsha metropolis.

6.0 DISTRIBUTION

Energy received from 132kV end of the transmission station, is transported down to distribution substation into a 33kV/11kV step down transformers. From these, the energy moves down to public distribution 11kV/415V step down transformers positioned in strategic places in street corners to the end users. At present, installation of MTR2 enabled optimal power supply to Army Barracks injection substation. Energy distribution is the transfer of electrical power to industrial, homes and commercial buildings. There are three general classifications of electrical power distribution systems: radial, ring and network systems (i) **Radial distribution system:** this is the simplest type since the power comes from one source. A generating system supplies power from the station through radial lines which are extended to various areas. Radial system is least reliable in terms of continuous service since there is no back-up distribution system connects to the single power source. If any power line opens, more than one load is interrupted. There is more likelihood of power outages. However, this system is least expensive. It is use in remote areas where other distribution system is not economically feasible.

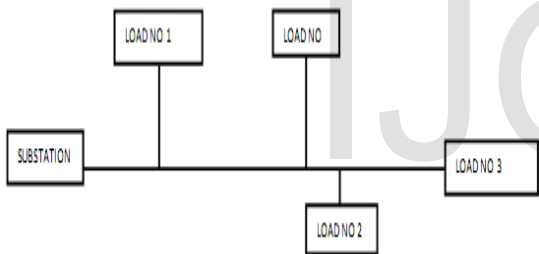


Figure 4: A Radial Power Distribution System.

(ii) **Ring distribution system:** This system is used in heavily populated areas like Onitsha Metropolis. The distribution line circles the service area. Power is delivered from one or more power sources into substations near the service area, and then distributed from the substations through the radial power line. When a power line is opened, no interruption to other loads occurs. This system provides a more continuous service than the radial system. Due to additional power lines and a greater circuit complexity, the ring system is more expensive. To attain reliable power supply, a ring system of distribution of energy is recommended. This system will minimise rate of total power outages in an area as failure of one arm of load will not affect all other area because you can feed from another side hence the RING distribution system.

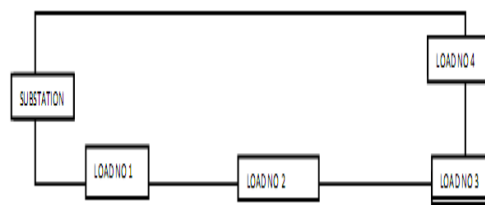


Figure 5: A Ring Power Distribution System.

(iii) **Network distribution system:** this is a combination of the radial and the ring system. They usually result when one of the other systems is expanded. Most of the power distribution systems of our electrical systems are network system. This system is more complex but provides very reliable service as each load is fed by two or more sources.

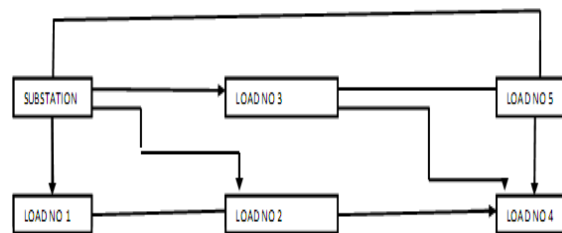


Figure 6: A Network Power Distribution System.

7.0 SUBSTATIONS IN ONITSHA METROPOLIS

There are three (3) main substations within the area under study namely, Atani, Army Barracks, and “3-3” Injection Substations. These injection substations operate a radial system of distributing energy. Although this type of distribution system is least reliable, it is used because it is less expensive.

- (a) Atani injection substation has installation capacity of 2 x 15MVA transformers and receives supply from 33kV side (secondary winding) of TR11. It feeds areas like Fegge, Housing Estate/Bank, Main Market, MCC layout and Iweka. Table 1 indicates the number of distribution transformers installed in Atani leg and their capacities.

Table 1 No and Capacities of Transformers in Atani Leg.

FEEDER	CAPACITY (kVA)				
	500	300	200	100	TOTAL
MKT	62	21	12	6	102
FEGGE	14	10	9	3	36

MCC/WATER/W	12	9	5	1	27
BANK/ HOUSING	8	4	9	10	31
IWEKA	13	9	1	NILL	22
TOAL	109	53	36	20	318

(b) Army Barracks injection substation has installation capacity of 15MVA and 7.5MVA transformers and receives supply from 33kV side (secondary winding) of MTR 2. It feeds GRA, INLAND, OMAGBA, and ODUME layouts respectively.

Table 2: No and Capacities of Transforms in Army Barracks Leg.

FEEDER	CAPACITY (kVA)				
	500	300	200	100	TOTAL
INLAND	32	21	10	3	66
GRA	24	20	26	6	76
OMAGA	20	18	13	7	58
ODUME	12	14	8	10	44
TOTAL	88	73	57	26	245

(c) 33/Umunya injection substation has installation capacity of 7.5m transformer. It receives supply from 33kv side of MTR 1 and it feeds area like 33, HOUSIHG, AKPAKA.

Table 3: No and Capacities of Transformers in 33/Umunya Leg.

FEEDER	CAPACITY (kVA)				
	500	300	200	100	TOTAL
HOUSE/AKPAKA	8	5	10	3	26

8.0 NIPP AND IPP PROJECTS IN ONITSHA TRANSMISSION CENTER

The NIPP and IPP projects in Onitsha transmission centre are transformers T3 and T4 of 150MVA capacity each at 330kV side, MTR2 of 40MVA at 132kV side of transformer and some of the injection substation lines were rerouted eg. Army Barracks. Also most 33kV and 11kV lines were re-conducted to increase their carrying capacity. Consequently, 33 injection substation of capacity 7.5MVA which was previously fed from Umunya leg now feeds from Army Barracks leg. The Inland leg that feeds from Awada 1 injection substation now has a dedicated feeder at Army Barracks injection substation. These NIPP installations tremendously improved power supply within the area under study as more corridors for conserving and evacuation of generated energy are created.

8.0 EFFECT OF NIPP AND IPP PROJECTS ON ELECTRIC SUPPLY IN ONITSHA METROPOLIS

Hourly readings of various feeders were taken which could be used to determine peak load, mid peak and off peak load periods when presented in a bar chart. It is evident from the daily and monthly readings taken that there is power delivery improvement in the NIPP era compare to pre NIPP era. In the pre NIPP era Energy sector was totally neglected. This was marked with obsolete equipment still in the system and there is no motivation to workforce. Power outages were a normal operational procedure. From the values of percentage availability (% AV), it is evident that consumers receive poor services. In this NIPP era, government is making more investments in the energy sector. There is more motivation in the workforce. From the analysis, average response time to attend to fault has been drastically reduced to less than two hours (2hrs) per fault. This is because operational vehicles and other essential materials are provided. Also prolonged outages are queried, so every service manager is always working harder. Values under the number of interruption and duration for various reasons are collected from [10].

9.0 RESULTS EVALUATION AND ANALYSIS

The bar charts in figs. 7 -12 clearly show remarkable improvement between the two conditions considered i.e. the pre NIPP/IPP era and the NIPP/IPP era.

Details show that the percentage availability of electric power (%AV) of pre NIPP/IPP era stood at 70.8% while that of the NIPP/IPP era gave 96% with an increase of roughly 25.2%.

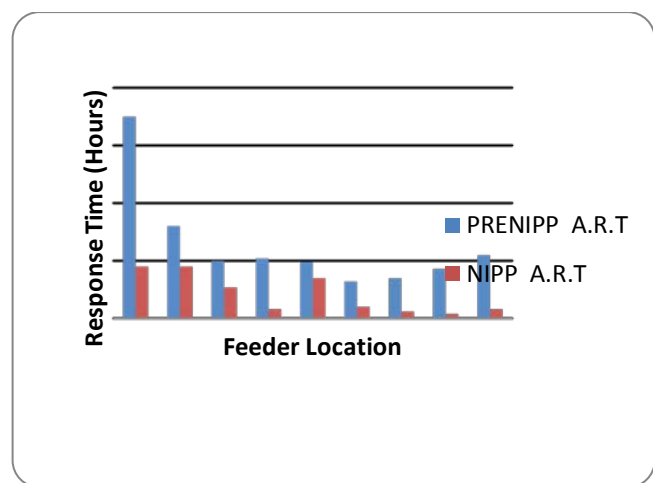


Figure 7: Chart showing average response time for Pre-NIPP / NIPP era

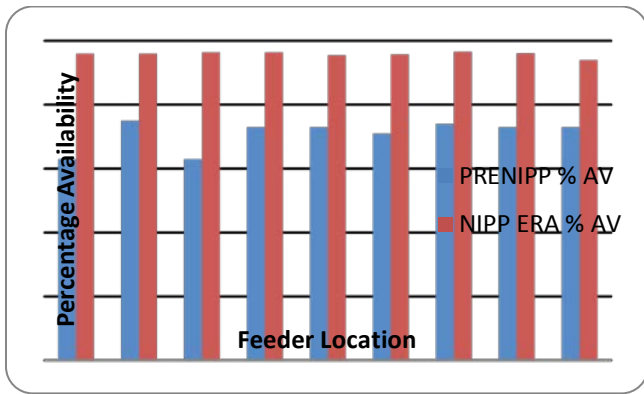


Figure 8: Chart showing Percentage availability for Pre-NIPP / NIPP era

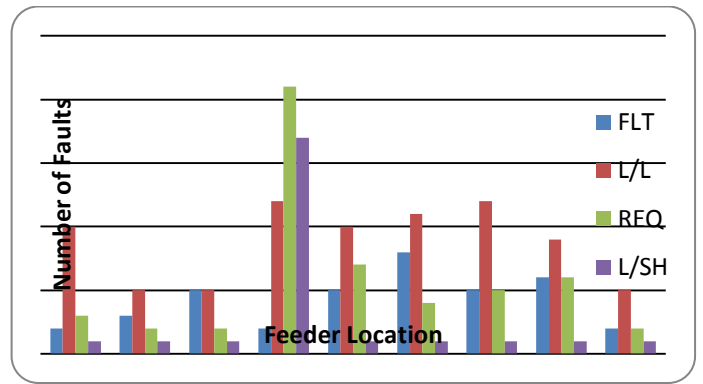


Figure 11: Chart showing Number of faults in different feeders in NIPP era

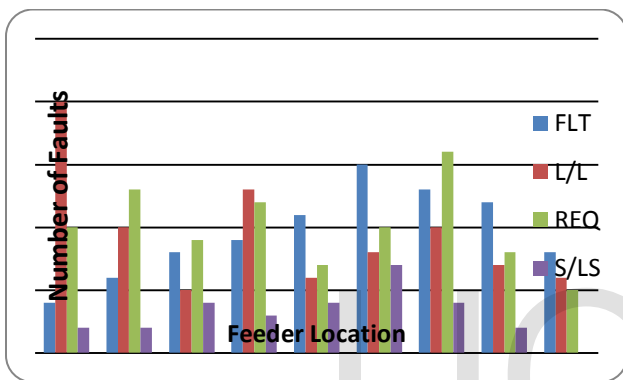


Figure 9: Chart showing Number of faults in different feeders in Pre-NIPP era

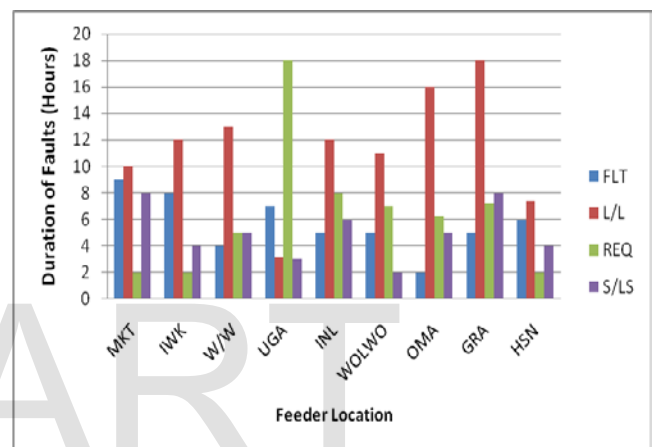


Figure 12: Chart showing duration of faults in different feeders in NIPP era

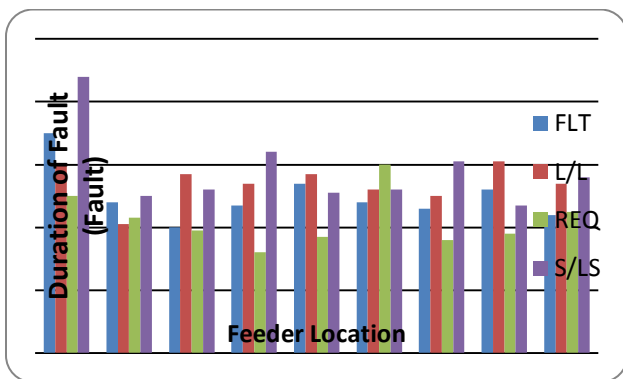


Figure 10: Chart showing duration of faults in different feeders in Pre-NIPP era

Faults or outages due to load shedding, load limitation dropped from 28 and 85 to 25 and 79 respectively. Serious improvement on the average response time (A.R.T.) from 57.1 to 17.1 is conspicuously shown and the difference is very clear. Due to the fairly reasonable improvement in power equipment in Onitsha work centre courtesy of NIPP/IPP projects, the work centre can now comfortably import additional 240MW of power assuming a power factor of 0.8 because of the two new 150MVA transformers on 330kV side. The 132kV side is not left out since it has one 40MVA transformer installed.

10.0 RECOMMENDATIONS

Consequent upon the results so obtained as in most figures and actualization of the target come 2015, it is seriously recommended that,

- i. More transmission lines be drawn possibly double circuit even triple lines should dominate the proposed

- lines by NIPP/IPP in order to increase efficiency and reliability.
- ii. More substations be constructed and equipped with sizable transformers.
- iii. The government should for once develop the political will to fully and judiciously implement the National Independent Power Projects (NIPP). It is very clear that the lack of political will in policy inconsistency have been why the government has failed severally to meet target generation level 2010-4000MW promised and 6000MW by 2011.
- iv. Existing Injection substations, transmission lines should be rehabilitated for better service.
- v. PHCN or bodies responsible for generation, transmission and distribution in the country at all levels to keep records and make such available to research students on demand for research work purposes.
- vi. Planned and routine maintenance should be carried out on the national grid network
- vii. PHCN, the Nigerian Electricity regulatory body or whosoever is responsible should make extra effort to sponsor research work on the national grid in order to avert some emergency problems on the grid [11].

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11.0 CONCLUSION

Effects inform of improvement on reliable and stable power supply due to NIPP/IPP projects as it concerns Onitsha metropolis has been investigated. Enough and appreciable improvements were noticed in Onitsha case. If all the recommendations are carefully and religiously put in place throughout the whole Country, the dream of the federal government of efficient, reliable, stable and dependable power supply come 2015 will be realised.

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