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RETOOLING NIGERIAS ELECTRICITY GENERATION SUB – SYSTEM FOR SUSTAINABLE GRID OPERATION

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ABSTRACT
Experts are varied in estimating the amount of power needed for national development. One expert estimated 297,900 MW by the year 2030 using a 13 percent Gross Domestic Product (GDP). The Power Sector Road Map's aspiration is 40,000 MW by the year 2020 while the preferred Vision 20:2020 target is 40GW (40,000 MW) available capacity. Vision 20:2020 further proposed that hydro sources contribute 10% of this value; thermal, 80%; coal, 6% and renewables, 4%. However, as at December 2017, Nigeria's total installed generating capacity was 12,324.40 MW. In order to assess the fundamentals and proffer solutions for the improvement of power generation to meet popular expectations, this work analyses the installed capacities of the nation from 1986 – 1995, on the one hand and from 2007 – 2016, on the other hand using graphical illustrations and tables. The gap between the two time phases was deliberate to create some effect. The results show that over the years, there has been an apparent, non – challance towards systematic development of Nigeria's power sector. To put a check to this deteriorating condition / trend, useful suggestions have been made.
KEYWORDS: power station, installed capacity, vandalisation, frequency control.

INTRODUCTION
According to Sambo et al (2009), the energy demand projection for Nigeria by the year 2030 is estimated at 297,900 MW based on 13 percent Gross Domestic Product (GDP). The corresponding energy supply within the same period is projected to be 276,229 MW. The Power Sector Road Map aspiration is 40,000 MW by the year 2020 (KPMG, 2012). In contrast, Nigeria has 27 power plants with total installed capacity of 12,324.40 MW as at the end of December, 2017 (Okoye, 2019a; NCC, 2017). However, quite a good number of these are not operational, resulting in further decline in power produced for consumption. In fact, the average available capacity is 6871.25 MW which is just 55.8% of the total installed capacity. Recently (Ajibade, 2019a) shows that ten out of the 27 generating plants were shut down for some reasons. Worse still, about 4,000 MWof electricity was said to be stranded (not evacuated) by the relevant authority (Ajibade, 2019b).

In addition, the Afam power station (gas - powered) was constructed way back in 1965 and had six of its units rehabilitated in 1982. The Delta plant (also gas - fired) was built in 1966; five of the generating units were rehabilitated in 1990. Even Egbin gas powered plant with highest installed capacity of 1320 MW was constructed in 1986. Nigeria's oldest hydropower plant (Kainji) became operational in 1968 and is now 51year old (Okoro, 2001; Okoye& Ali, 2010; Okoye et al, 2017; Okoye et al, 2018a; Okoye et al, 2018b).

Gas Supply is critical factor in power value chain.Apart from the three hydropower stations, the rest of the plants depend on gas for their operation. According to NSE (2017), Nigeria's oil and gas infrastructure is in power state and is on the verge of failure and needs urgent rehabilitation to prevent complete failure. All along, the Generation companies (Gencos) Transmission Company (Transco) and the Distribution Companies (Discos), the tripod on which power sector is standing keep shifting blames for poor power generation. For instance, when the Gencos alleged sometime in October, 2019 that 4000 MW of power was stranded, the Discos denied that no power was stranded. An argument levelled against Transco for inability to wheel power to Discos is the fragile nature of the transmission network. Transco turned around to blame poor generation on gas shortage on the one hand, and inability of Discos to take more load, on the other hand. Vandals are also fingered at as contributing to the crisis in power sector because of their illegal activities (NCC, 2018).

For instance, the Sagamu – Ijebu Ode 132 kV lines and the New Haven OturkpoYandev 132 kV lines were some time ago vandalized; throwing some states into total darkness. (Okoye, 2015)
The result of all this is that power generation keeps fluctuating between 1500 MW and 3500 MW. This work seeks to improve the power supply in Nigeria by data – based analysis of key issues.

MATERIALS AND METHODS

Part of the planning stage of this research work was visit to the National Control Centre. (NCC), the Transmission Company of Nigeria (TCN) both at Osogbo, Nigeria; Olorunsogo thermal power station and further field trips to 15 MVA, 33 / 11 kV substation at Ilaro, Ogun State, Nigeria.
Frequency control to enhance Voltage Profile and System Stability was observed at the NCC. Any time there is less MW electrical load demanded, frequency would rise above 50Hz. An increase in MW electrical load demanded would lead to a fall in frequency below the standard 50Hz. In both cases, poor voltage profile and system instability would result.
Key technical staff at the various places visited were also interviewed and information garnered further enriched the work. Besides useful information were gathered from literature such as Nigeria's Economic Recovery Growth Plan (ERGP) 2017 – 2020, Electric Power Infrastructure; The Nigerian Infrastructure Report Card 2017, and various Annual Technical Reports of the NCC and selected publications of the Central Bank of Nigeria Bulletins and Bureau for Public Enterprises.
To further organise the work, data on installed capacity by year for 10 years (1986 - 1995) was collected and tagged Batch I. Then followed by data on installed capacity for another 10 years (2007 - 2016) called Batch II. The gap (1996 - 2006) between Batch 1 and Batch II was deliberately created for effect so that the degree of capacity addition 11 years after Batch I could be better felt or assessed.

Table 1.0 Installed capacity by year (1986 - 1995) in MW, Batch I

S/N	Year	Installed Capacity (MW)
1	1986	4548.0
2	1987	4548.0
3	1988	4548.0
4	1989	4548.0
5	1990	4548.0
6	1991	4548.0
7	1992	4548.0
8	1993	4548.6
9	1994	4548.6
10	1995	4548.6

Source: National Control Centre & Central Bank of Nigeria Bulletin

Table 2.0 Installed capacity by year (2007 - 2016) in MW, Batch II

S/N	Year	Installed Capacity (MW)
1	2007	8138.00
2	2008	8469.50
3	2009	8702.25
4	2010	8425.40
5	2011	8910.40
6	2012	9955.40
7	2013	10915.40
8	2014	11165.40
9	2015	12132.40
10	2016	12310.40

Source: National Control Centre

Table 3.0 Age of major power stations in Nigeria's national grid

S/N	Power station	Location	Installed capacity MW	Source of energy	Year of Construction
1	Kainji	Kaiji, Niger State	760	Hydro	1968
2	Jebba	Jebba, Niger State	540	Hydro	1985
3	Shiroro	Shiroro, Niger State	600	Hydro	1989
4	Egbin	Egbin, Lagos State	1320	Gas	1986
5	Afam (IV - V)	Afam, Rivers State	711 (6 x 77, 1982)	Gas	1965, 1982
6	Sapele	Sapele, Delta State	1020	Gas	1978 / 1981
7	Delta	Ughelli, Delta State	912 (5 x 100, 1990)	Gas	1966, 1990
8	Oji	Oji, Achi, Enugu State	30 (scrapped)	Coal	1956

Source: National Bureau of Public Enterprises and National Control Centre, Osogbo.

RESULTS AND DISCUSSION

To further deduce some meanings from Tables 1.0, the data is used to plot the graph shown in fig 1.0

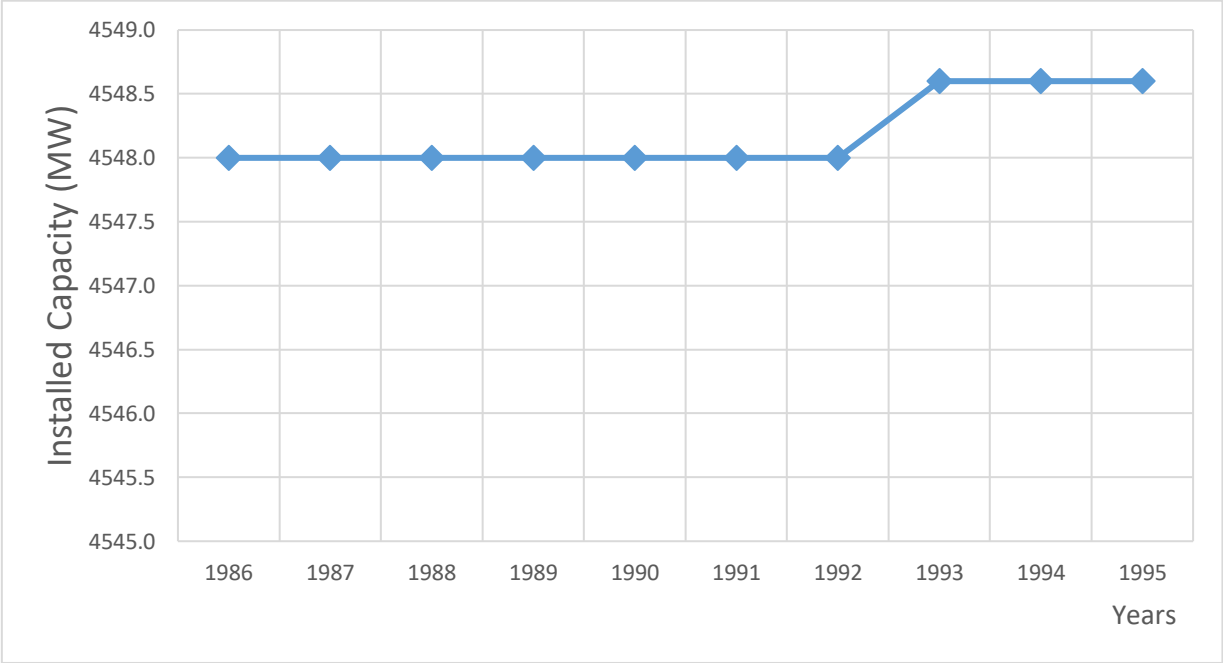

Fig. 1.0: Graphical illustration of Capacity addition over the years (1986 - 1995)

It should be observed in Fig 1.0 that no new capacity was added in the entire seven years (1986 - 1992). It was only in 1993 that a slight addition was made only to remain so for the rest of 1994 and 1995.
Similarly, Fig 2.0 results when data in Table 2.0 was plotted.
From Table 2.0 and Fig 2.0, after 11 years had elapsed, it was observed that installed capacity has risen to 8,138.0MW as at 2007. The argument is that it took about11 years from 1995 to attain an additional installed capacity of about 3.6 MW from the 1995 level. Fig 2.0 further shows that from 2011, there was a rise in capacity addition but it was not remarkable.

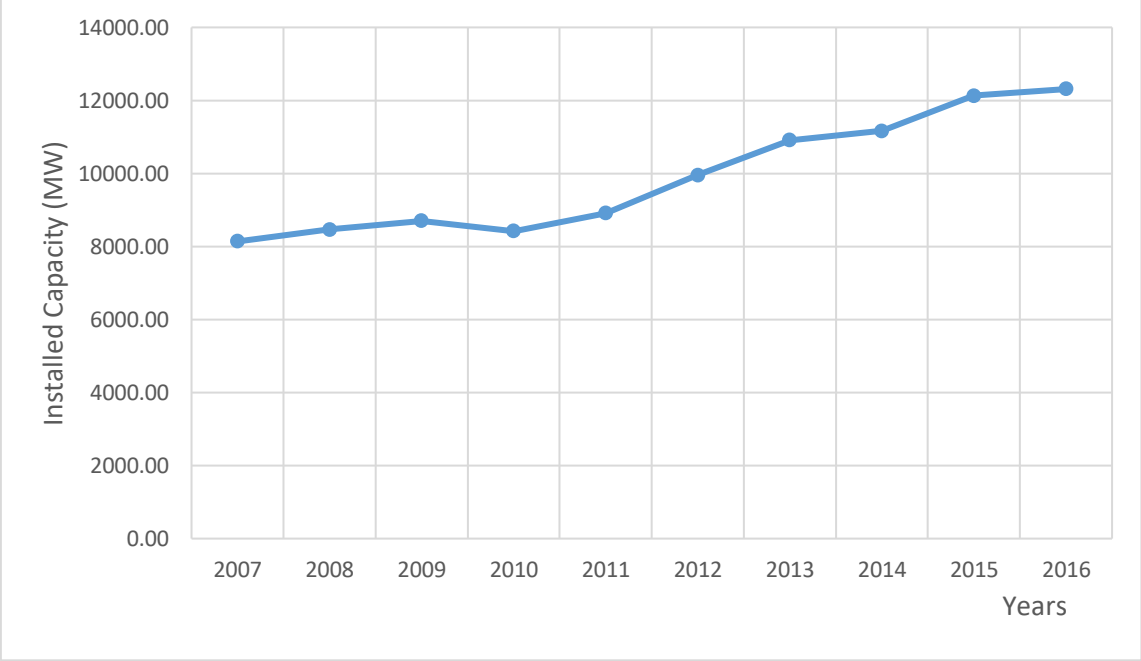

Fig. 2.0: Graphical illustration of Capacity addition, (2007 - 2016)

Furthermore, attention is drawn to Table 3.0 where all the major power plants are fast aging and approaching end of their service life with Kainji, for instance, being 51 years. It is, therefore obvious that their performance has declined. Comparatively, the U.S. electric grid (Hicks, 2012) comprises over 5000 state-of-the-art power plants operating at high efficiency.

To further establish or size – up the extent capacity addition was pursued or carried out even after 11 whole years have passed / elapsed, Tables 1.0 and 2.0 were plotted on the same graph to produce Fig 3.0.

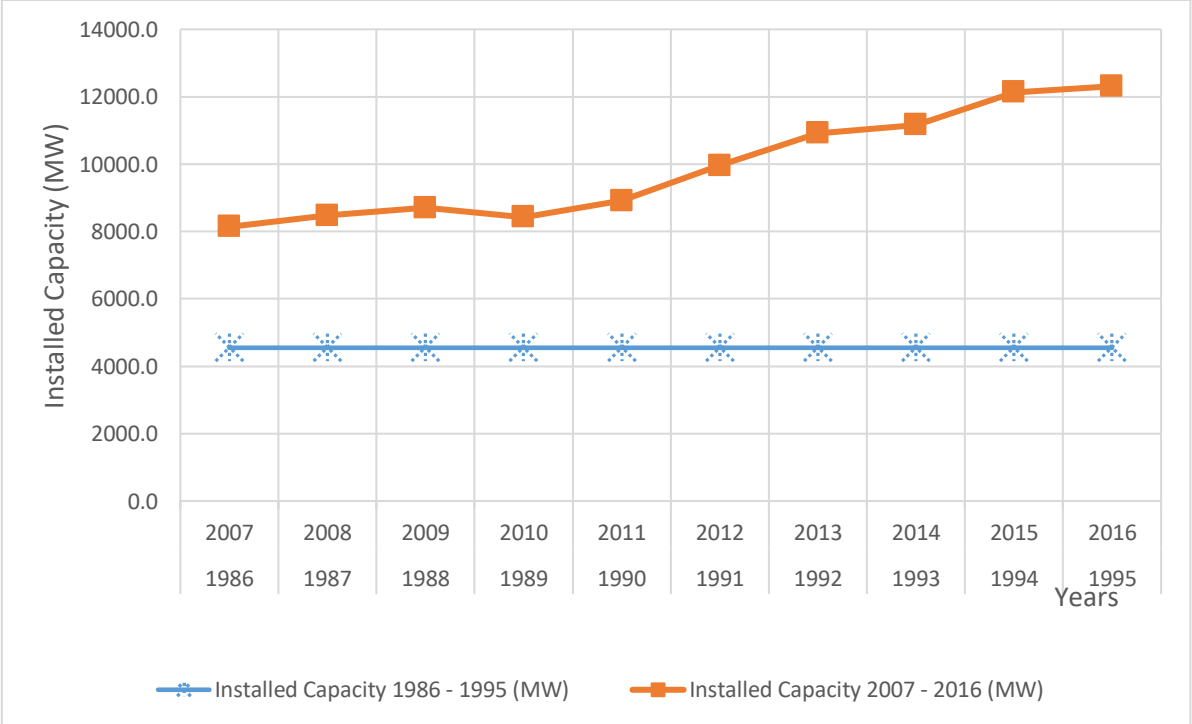

Fig. 3.0: Graphical illustration of relative development in capacity addition, 1986 – 1995; 2007 – 2016

In addition, Fig 4.0. is the further representation of Tables 1.0 and 2.0 using bar chart. Where the picture of the issues at stake are even much more clearer.

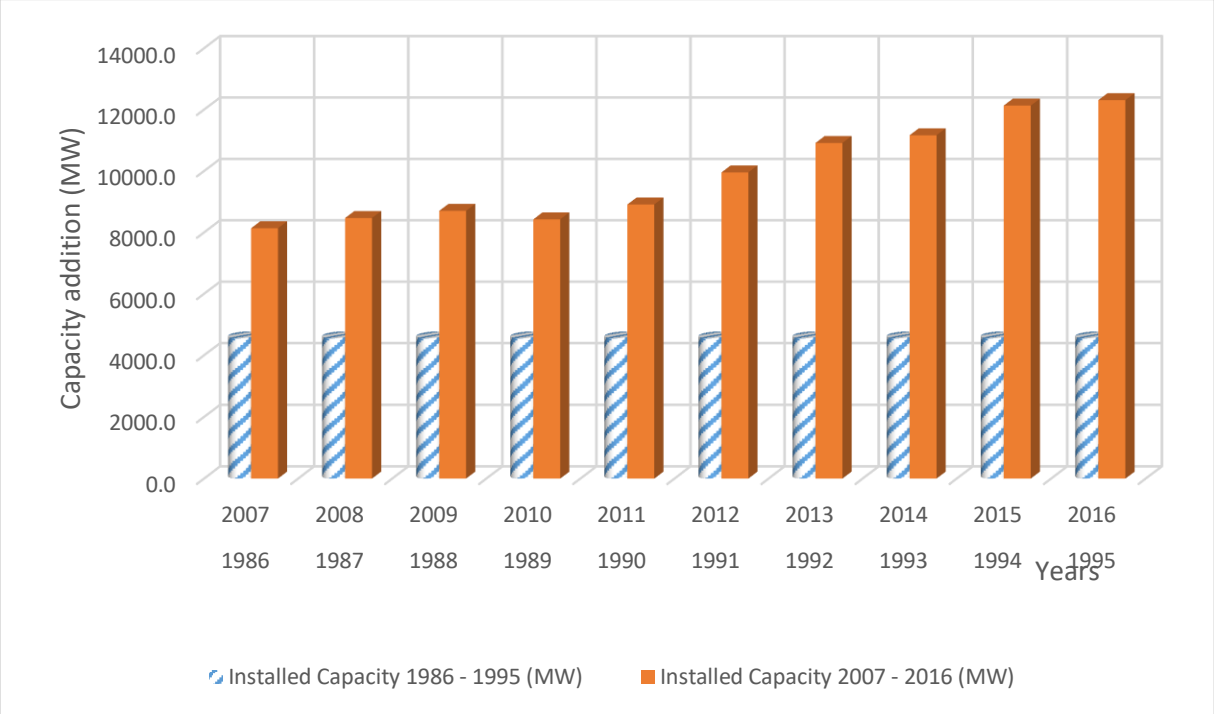

Fig. 4.0: Chart comparing capacity addition, 1986 – 1995 and 2007 - 2016

The following are suggested for improvement of power generating capacity of Nigeria:

- Nigeria is not using her coal resources to generate electricity, though coal is abundant in 18 states of the federation (Otenaike & Onifade, 2017) with astonishing reserve of 2.7 billion metric tonnes that is said could last for 200 years (Amoda, 2016; Okoye 2018b). Whereas coal is used to generate 41% of electricity used worldwide, 72 – 93% of South Africa's energy demand is met from coal. (ALAMAU, 2016). According to Otenaike and Onifade (2017), China generates 79% of her electric power from coal; India (68%); Poland (87%); Morocco (51%) and U.S.A (45%). The 30MW coal – fired power plant in Oji, Enugu State scrapped long time ago should be reactivated and new ones added.
- The Independent Power Plants IPPs connected to the grid have approximated 2191 MW of installed capacity with only 1203.40 MW available as at December, 2017 (NCC, 2017). More of such IPPs should be built and conducive environment provided for them. Babcock University's IPP generates 4.4 MW of power for its use 24 hours daily (Uwandu, 2019).
- Research has shown that one of the major problems faced by generating companies is inadequate gas supply. For instance, Opara (2014) reports that 90% of the IPP licenses are non – operational as a result of gas supply shortages. This is a country that has 187 trillion Standard Cubic Feet (SCF) of proven gas reserves and 600 trillion SCF of unproven gas reserves (Sambo, 2008; FRN, 2012). The Nigerian Gas Company (NGC) or whatever organ that is responsible for providing gas supplies should find lasting solution to gas inadequacy.
- Huge debts (over one trillion naira) are being owed generating companies by distribution companies (Ajibade, 2019d). The Nigerian Bulk Electricity Trading Company (NBET) Should ensure that Discos pay these debts so that Gencos could improve on their power output. NBET was set up by the federal government of Nigeria to administer and control energy pool.
- Another critical factor militating against generation is vandalisation of power infrastructure and gas pipelines. This act of sabotage is obvious everywhere in Nigeria. Without putting this in check, all efforts to improve electricity supply will pay little dividend.
- Table 3.0 shows that many power plants are already very old. Thus, they keep failing after due maintenance. Though capital intensive, additional ones should be built as the economy is expanding fast. After all, Nigeria is said to be the largest economy in Africa.

- It is high time to scale up renewable energy development and deployment in Nigeria. Apart from the advantage of having no obvious negative impact on the environment, it could also provide relief to rural dwellers in remote areas in Nigeria. This will reduce dependence on grid electricity with all its attendant disappointing performances.

CONCLUSION

As the largest economy in Africa, there is an urgent need to increase power supply in Nigeria. The minimum installed generation capacity proposed by experts is 40,000 MW by the year 2020 but Nigeria is nowhere near this optimistic figure as at present. Rather, the country is grappling with the installed capacity of only 12,324 MW with only about half of it suitable and ready for electricity generation. The study has shown graphically that from 1986 to date, capacity addition has not been anything impressive and points at some obvious neglect of power sector over the years, coal is a major source of power in countries like China (79.1%), India (68%), Poland (87%), Germany (41%), Israel (58%), and even Morocco (51%). Nigeria with coal deposits in 18 states and huge reserve of 2.7 billion metric tonnes is expected to have been a leader in coal – fired power generation. Unfortunately, even the only coal – fired power station in Oji, Enugu State, commissioned in 1956 has been scrapped and nobody appears to be thinking about it anymore.
Measures aimed at power supply for Nigeria's 200 million people and, of course, Benin and Niger Republics which Nigeria sales electricity to have been suggested.

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