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ANALYSIS OF GRID CONNECTED INDEPENDENT POWER PLANT CAPABILITIES ON ELECTRICITY GENERATION SPECTRUM IN NIGERIA

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ABSTRACT

At the core of any meaningful economic activity is electric power. Absence or inadequacy of it in a nation stalls development in that nation. In Nigeria, there is a wide gap between forecast power and actual power generation needed for productive endeavours. For instance in July 2017, the generation peak load forecast was 14190MW while the actual generation peak load was 4567MW. In July 2018 it was again 14190MW (forecast) but 5110MW (actual). This paper uses descriptive statistics to analyse Independent Power Plant (IPP) capabilities spread across ten years (2009-2018). The results show that there is need to encourage more private investors to build additional IPPs in order to increase adequate power generation in Nigeria – especially in post-COVID-19 socio-economic crisis. Consequently, it is expected that the wide gap between generation peak load peak load forecast and actual peak load would be narrowed.

Keywords: Independent Power Plants (IPPs), forecast, generation, installed capacity, available capacity.

I. INTRODUCTION

Nigeria's power sector is a huge machine, comprising mainly generation, transmission and distribution sub-systems. Unfortunately, all these sub-systems are bedeviled with much challenges. Consequently, electricity consumers are daily faced with acute lack of power for productive activities. The nations power generation capacity as at December, 2018 was 12910.40MW and this was just the installed (nameplate) capacity of the grid-connected power plants [1]. Typically, in July, 2018, the generation peak load forecast was 14190MW while the actual generation peak load was 5110MW which was just 36% of the generation peak load forecast. It is difficult to estimate the actual electricity generated and consumed in Nigeria because most consumers now rely on petrol and diesel generating units for own power. In a study [2], it was revealed that Nigerians expend over ₦179 billion annually on fuel for dedicated generators; the highest the world over. Dangote Cement, Ibese, Nigeria was said to spend ₦250 million daily before embarking on generating its own power [3].

When more power is drawn by the load beyond the total electricity generated, the system frequency begins to fall from the ideal 50Hz level. Without additional generation or load-shedding, the power system will experience under frequency collapse (loss of stability and fall out of step).and this is one of the causes of the power outage in a power system [4],[5]. To increase the total installed capacity and available generation capacity there is need to encourage the development Independent Power Plants (IPPs). This must be taken seriously because year 2020 is here with us and Nigeria is far from achieving the much orchestrated Vision 20: 2020 power target. The target of Nigeria's Vision 20: 2020 is to increase the installed generation capacity from the 2009 figure (6000MW) to 20,000MW by 2015 and 35,000MW by 2020. This poor state of affair has been emphasized several times in literature [6],[7],[8],[9].

Most industries in Nigeria generate their own electricity due to the unreliability of grid electricity. According to [10], 86% of firms in the country use diesel fuel to generate power for their own use. Some others such as Dangote Cement, Ibese, Nigeria utilizes natural gas to achieve the same purpose. Yet, a few other Independent Power Producers, produce electricity in excess of their need and thus sell the excess through national grid network. Some notable IPPs connected to the national grid are Okpai gas plant, Afam VI, Azura, A.E.S., ASCO, Paras, Ibom and Omoku gas plant [1],[11],[12]. Their total installed capacity

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as at December, 2018 was 2652.00MW which is 20.5% of the total national grid installed capacity of 12910.40MW (Thermal and Hydro).

Since the reason for licensing the IPPs by the Nigerian Electricity Regulatory Commission (NERC) is mainly to compliment the aggregate energy generation and to help in reducing gas flaring, more investors should be encouraged to build capacity in this area to mitigate energy crises in post-COVID-19 socio-economic development. Table 1.0 shows some licensed IPPs in Nigeria and their site ratings/capacities.

Table-1: A typical Licensed IPPs in Nigeria

S/N	Power Station	Capacity (MW)	Status
1.	Index thermal power Ltd	1800	Licence granted
2.	Agbara shoeline power co. Ltd	1800	Licence granted
3.	Shell Distribution co. Ltd	100	Licence granted
4.	Ibafo power station Ltd	640	Licence granted
5.	Hadson Power Station Ltd	200	Licence granted
6.	First Independent Power Co. Ltd	150	Licence granted
7.	Anita Energy Ltd	136	Licence granted
8.	Lotust Bresson Nig. Ltd	60	Licence granted
9.	Weston Tech & Energy Services Ltd	1000	Licence granted
10.	Ethiope Energy Ltd	2800	Approved Licence
11.	Farm Electric Supply Ltd	150	Approved Licence
12.	ICS power	624	Approved Licence
13.	Supertech Ltd	1000	Approved Licence
14.	Mabon Ltd	39	Approved Licence
15.	Geometric Ltd	140	Approved Licence
	Total	**10,639**	

Source: [13]

In 2009 about 29 IPPs were licensed by the NERC to build power plants in Nigeria. However, many have not utilised this opportunity made available to them due to constraints such as harsh economic environment and gas shortage, [14],[15]. [16] reports that 90% of power licenses were unused due to inadequacy of natural gas, the major fuel for the proposed plants.

II. METHODOLOGY

Data were collected periodically from the National Control Centre (NCC), Osogbo, Nigeria and the Transmission Company of Nigeria (TCN), respectively. Visits were also made to Olorunsogo I and Olorunsogo NIPP thermal power stations which are a few kilometers from the Federal Polytechnic Ilaro, Nigeria where the researchers live and work.

Dangote Cement, Ibese is about five-minute drive from Ilaro and its thermal IPP was also visited. Numerous journals, textbooks and other literature sources crucial to the work were adequately consulted also and information classified as follows:

- Installed capacity, IPP (MW): 2009 – 2018.
- Average availability (average available capacity) MW: 2009 – 2018
- Installed capacity; all other grid-connected plants (MW): 2009 – 2018

- Available capacity, all other grid-connected plants (MW): 2009-2018
- Grid-connected IPPs in Nigeria as at December, 2018, MW.

By all other grid-connected plants, what is meant is all the hydro and the rest of the thermal power plants generating electricity to the grid/power network. Some of them are: Kainji hydropower plant, Jebba hydro, Shiroro hydro, Egbin thermal, Afam (I-V), Sapele, Olorunsogo, and Omotosho thermal power plants (among others).

As at December 2018, the total installed capacity of all the three hydro plants was 1938.40 MW with average availability of 1253.71 MW (which is 64.7%) of the total installed hydro capacity (NCC, 2018). For thermal, it was 8320 MW which is 53.2% of the total installed thermal plants.

Availability factor (A.F) as calculated in Table 3.0 is given as:

$$A.F = \frac{Average\ availability}{Installed\ capacity}$$

Thus, for Rivers IPP,

$$A.F = \frac{135.00}{180.00} = 0.75$$

For Omoku IPP,

$$A.F = \frac{68.94}{150.00} = 0.46$$

For Okpai IPP,

$$A.F = \frac{345.52}{480.00} = 0.72, etc$$

In the case of ASCO (Table 3.0), A.F = 0. This means that did not generate electricity within the period. This means that there was no grid-connected IPP at the time; hence no electricity generation from them.

III. RESULTS AND DISCUSSION

The data collected were analysed with the aid of descriptive statistics (charts and graphs) as detailed below.

Table-2: Installed and Available Capacities of IPPs Relative to all Other Power Plants. (2009-2018)

Year	Installed Capacity, IPP (MW)	Average Available Capacity, IPP (MW)	Installed Capacity, all other grid-connected plants (MW)	Available Capacity, all other grid-connected plants (MW)
2009	NA	NA	8,702.25	4,825.17
2010	NA	NA	8,425.40	4,212.70
2011	1,947.00	1,289.26	6,963.40	3,190.06
2012	2,017.00	1,384.93	7,938.40	4,131.45
2013	2,127.00	1,192.14	8,788.40	3,858.85
2014	2,127.00	1,451.54	9,038.40	4,866.16
2015	2,119.00	1,173.43	10,013.40	5,227.77
2016	2,177.00	1,243.33	10,133.40	6,634.66
2017	2,191.00	1,203.24	10,133.40	5,668.01
2018	2,652.00	1,684.23	10,258.40	5,683.71
Total	**17,357.00**	**10,622.10**	**90,394.85**	**48,298.54**

Key: NA (not available): No IPP was connected to the grid at the time. All IPPs are gas-powered.

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Source: Computed from Annual Technical Reports, 2009 – 2018, National Control Centre (NCC), Osogbo, Nigeria.

The situation presented in Table 2.0 could be better appreciated when put in a chart.

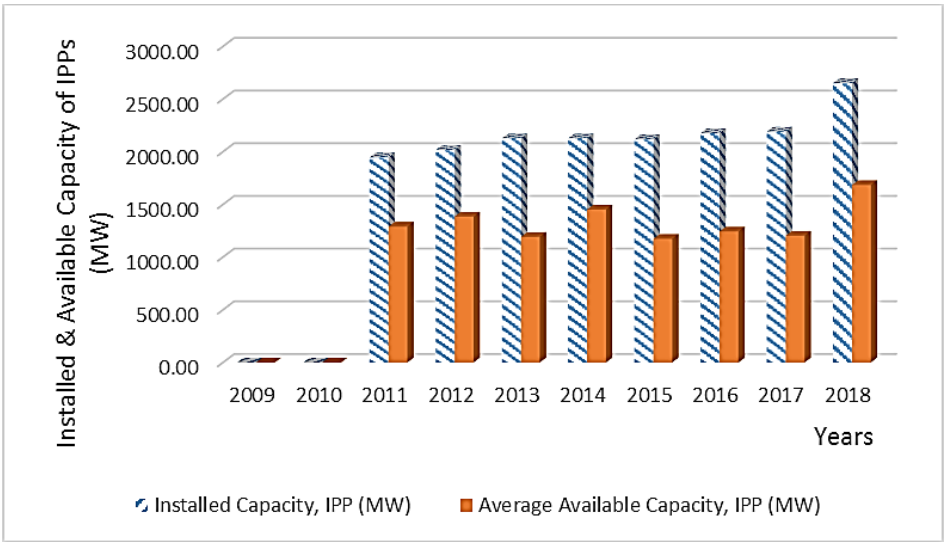

Fig.-1: Chart illustrating installed and available capacities of IPPs (2009-2018)

From here, observe that the installed and available capacities in 2018 were the highest ever achieved in the 10-year period.

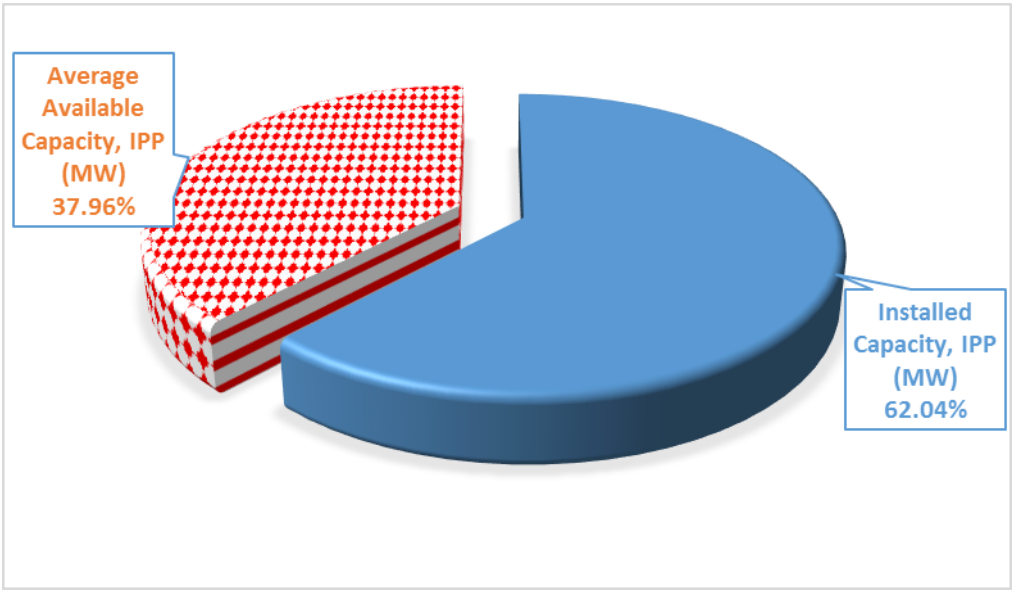

Fig.-2: Pie chart of installed capacity of IPPs and available capacity

Fig. 2.0 illustrates the aggregated installed and available capacities in the 10 years under study. The available capacity is clearly below the installed capacity. Hence, total electricity generation was poor.

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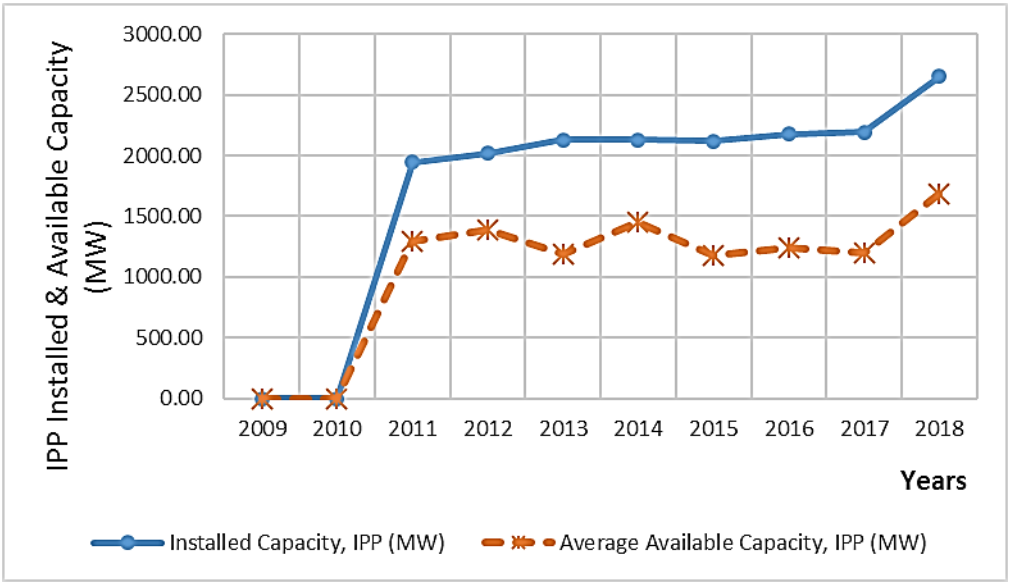

Fig.-3: Graphical presentation of IPP installed capacity of IPPs and available capacity (2009-2018)

In Fig. 3.0., it is depicted that between 2009 and 2010, no IPP (where it existed) was connected to the national grid hence the flattened portion. Further observe that there is an increasing gap between the contribution of the IPPs to the grid from 2010 when they were connected to the grid to 2018.

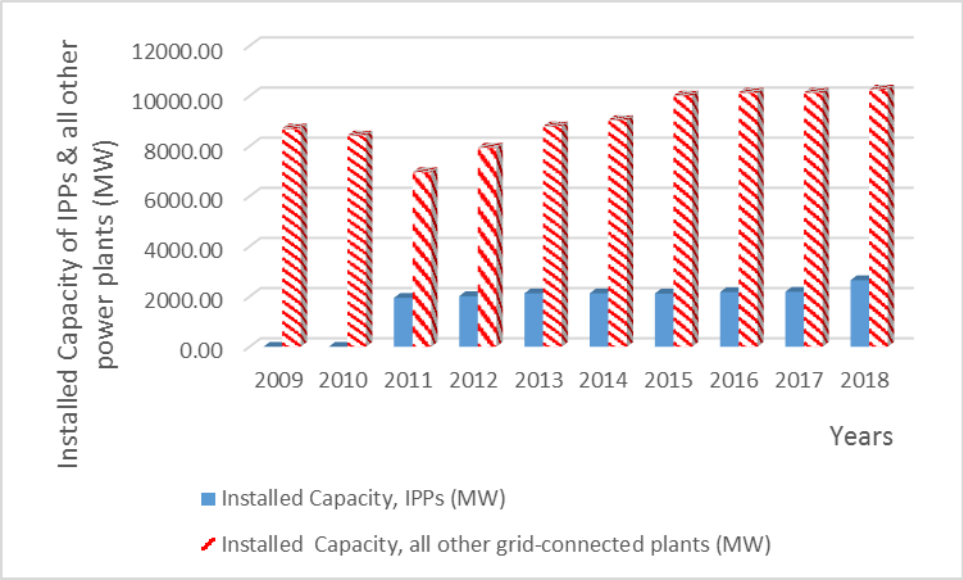

Fig.-4: Charted representation of IPP installed capacity in relation to all other power plants in the grid (2009 - 2018)

In Fig. 4.0., the installed capacities of IPPs relative to all other grid-connected (hydro and thermal) power plants are shown much more clearly.

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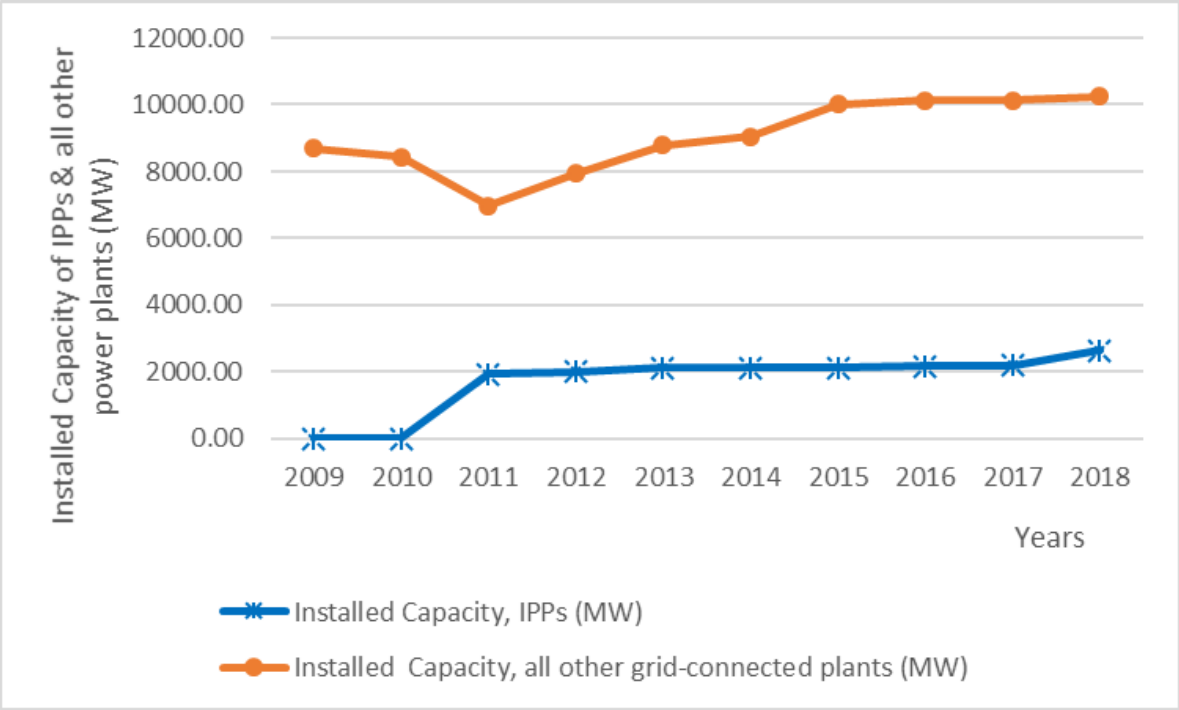

Fig.-5: Graphical illustration of installed capacity of IPPs and the rest of the power plants connected to the grid network (2009 - 2018)

To further convey the same information in Fig. 4.0, in a different way, Fig. 5.0 was plotted.

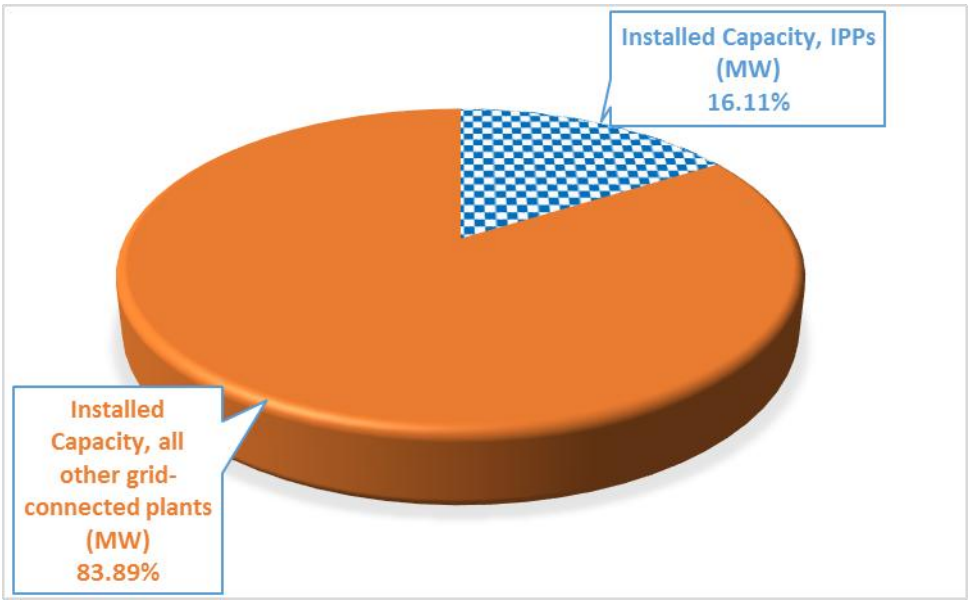

Fig.-6: Pie chart of installed capacity of IPPs relative to installed capacity of all other power plants.

From Fig. 6.0, it is clear that the installed capacity of the IPPs in the 10-year period did not increase appreciably.

Table-3: Grid-Connected Independent Power Plants (IPPs) in Nigeria as at December, 2018.

S/N	Power Station/Plant	Installed Capacity (MW)	Average Available Capacity (MW)	Availability Factor
1	Rivers IPP	180.00	135.08	0.75
2	Omoku	150.00	68.94	0.46

3	ASCO	110.00	0.00	0.00
4	Trans-Amadi	100.00	49.15	0.49
5	Okpa	480.00	345.52	0.72
6	Ibom	155.00	95.23	0.61
7	Paras	72.00	68.31	0.95
8	Azura	461.00	335.92	0.73
9	A.E.S.	294.00	0.00	0.00
	Total	**2652.00**	**1684.23**	**0.57**

Source: Extracted from Annual Technical Reports, National Control Centre (NCC), Osogbo, Nigeria. (2018)

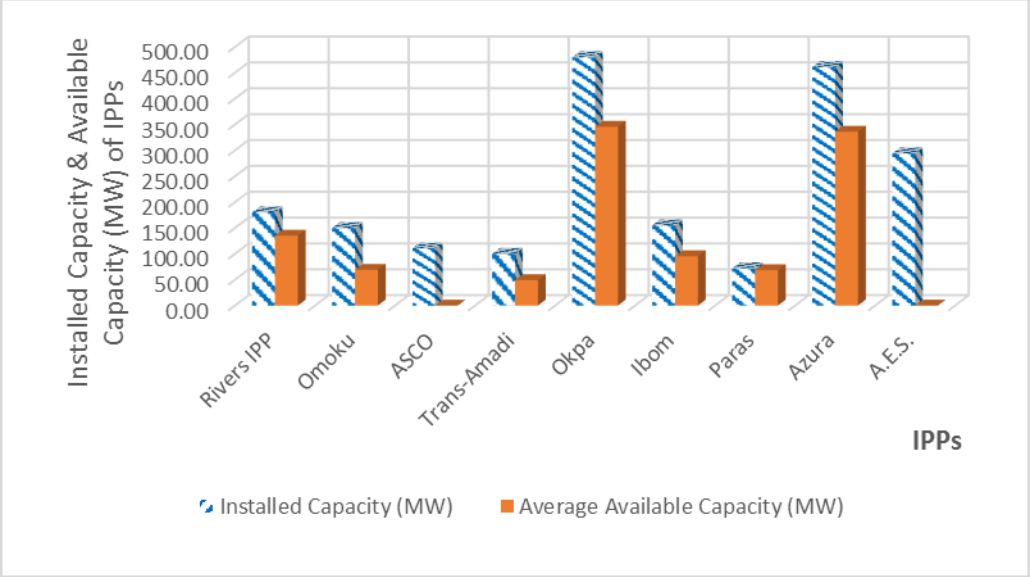

Fig.-7: Chart Showing the installed and available capacities of IPPs as at Dec. 2018

From Table 3.0, the chart in Fig. 7.0 was produced. This represents fairly the IPP installed and available capacities as they are in Nigeria as at December 2018. This argument is further advanced graphically in Fig. 8.0. This situation in 2020 may not be any different.

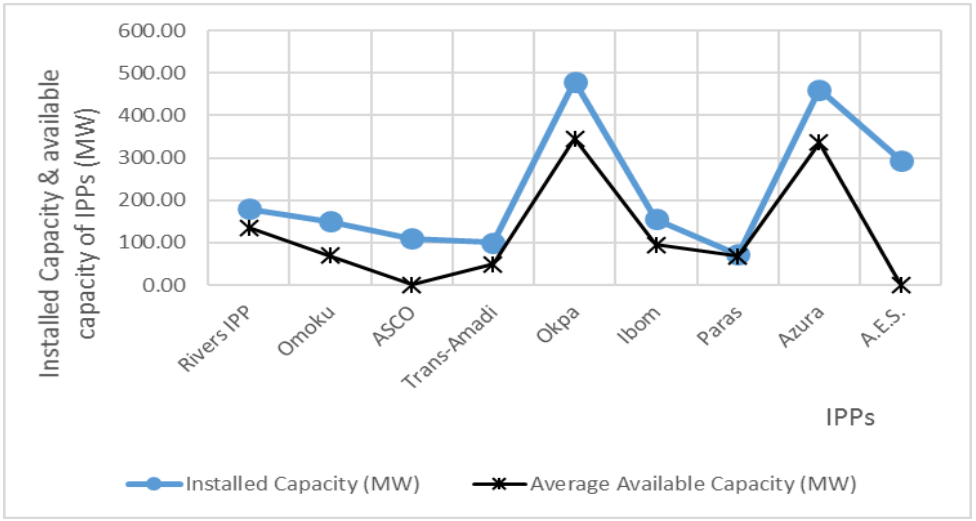

Fig.-8: Graphical representation of installed and available capacities of IPPs (2018)

Babcock University currently operates a 4.4 MW IPP that continuously supplies power to the institution day and night [17]. The plant is even of much higher rating than many of the grid-connected IPPs listed in Table 3.0. Similarly, Dangote Cement's IPP, Ibese, Ogun State, Nigeria, generated 406762.33 MWH of energy in 2013 which when compared with the 29628699.32 MWH generated by the national grid represents 1.4% of Nigeria's total energy generation in 2013 [7]. Both and similar promising IPPs in the nation should be encouraged to produce more than their need and to sell the excess to grid operators.

IV. CONCLUSION

There is no doubt that Nigeria needs increasing electricity generation and availability to meet the challenges of development worsened by the negative effect of Covid-19 pandemic. The current power generating capacity and availability is not in any way encouraging. Even if all the **12910MW** installed generating capacity is fully utilized, this is still far below the vision 20:2020 target of 40,000MW. The Independent Power Plants (IPPs) constitute only about 20% of the nation's installed generating capacity. Among other things; emphasis should be on creating an enabling environment for investors to not only build more thermal gas-fired plants, but also to exploit Nigeria's huge potentials in renewable energy such as small hydropower, wind and solar technologies.

RECOMMENDATIONS

- It is high time Nigeria intensified effort at encouraging the construction and development of IPPs across board. Apart from those connected to the national grid, some organisations/industries are courageously breaking ground in this area. Babcock university Ilishan-Remo, Ogun State, Nigeria sometime ago announced that its 4.4MW IPP produced 24hours of uninterrupted power [17]. Dangote cement, Ibese, Nigeria also generates its own electricity at 11KV using natural gas. If encouraged, the industry can convincingly contribute to grid generation capacity with a minimal power loss of about 1.2%. In a study, [7], its generation represented about 1.4%of Nigeria's total 2013 energy generation.
- Prospective Independent Power Producers should endeavour to explore and exploit renewable energy capacity of Nigeria. For instance, the large and small hydropower potentials are about 11,500MW and 734MW respectively [18]. Wind resource has a potential of 2-6m/s at 10m height while solar has 3.5-7.0 Kw/m/day with corresponding sunshine of 4-8hours/day.
- All the grid-connected IPPs and even the licensed/approved ones (Tables 1.0 and 3.0) are all gas dependent. It is expected that their huge demand for natural gas would ultimately lead to reduction in gas flaring. However, this objective has not been realised to an extent. The reason most have not even started operation is because of acute shortage of gas [16]. So, gas supply must be improved upon to enhance IPP construction and deployment.
- The more power stations are built and operated; the more socio-economic activities are simulated; hence more jobs are likely to be created for the teaming youth-especially in post-COVID era.
- Prospective IPPs should be given some financial assistance by making policies that encourage cost reduction in their investments [19].

V. REFERENCES

[1] NCC (2018), Annual Technical Report, National Control Centre, Osogbo, Nigeria.
[2] Ebhota, W.S & Tabakov, P.Y (2018), Power Inadequacy, the thorn in Economic Growth in Nigeria, International Journal of Applied Energy Research, Vol.13, No 16, pp 12602 -12610.
[3] AIT (2014), African Independent Television, Newspaper Review, August 18.
[4] Rao, S. (2008), Testing, Commissioning, Operation, and Maintenance of Electrical Equipment, Khanna Publisher., New Delhi.
[5] Okoye, C.U. & Omolola, S.A (2019a), A Study and Evaluation of Power Outages on 132KV Transmission Network in Nigeria for Grid Security, The International Journal of Engineering and Science, Vol. 8, Issue 11, pp. 53-57.

[6] Okoye, C,U., Omolola, S.A., Adelakun, N.O., & Bitrus, I. (2019b), Retooling Nigeria's Electricity Generation Sub-System for Sustainable Grid Operation, International Journal of Innovations in Engineering Research and Technology, Vol.6, Issue 12, December. Pp.7-13

[7] Okoye, C.U., Alao M.J., Bitrus, I., Adelakun N.O., & Abdulhamid, I.G. (2018), A Study and Analysis of Energy Generation and Consumption in Dangote Cement Plant, Ibese, Nigeria. Global Journal of Advanced Engineering Technologies and Sciences. Vol.5 No 11.

[8] KPMG (2019), Nigeria's Electricity Supply Industry Highlights, Power Sector Watch, Edition Q.3.

[9] CSEA (2019), Energy for Growth Hub, Power Nextier, May edition.

[10] NSE (2017), The Nigerian Infrastructure Report Card 2017, Nigerian Society of Engineers.

[11] ERGP (2017), Economic Recovery Growth Plan 2017-2020, Ministry of Budget and National Planning, Federal Republic of Nigeria.

[12] Fashola, B.R. (2017), Power Sector Reforms: Challenges and the Way Forward, paper presented at the 2017 Public lecture series, Department of Economics, University of Lagos, Nigeria.

[13] Sambo, A.S.; Garba, B.; Zarma, I.H. & Gaji, M.M. (2010) Electricity generation and the present challenges in the Nigerian power sector, Energy company of Nigera, Nigeria.

[14] Gasau, A.M.& Orah, A.M (2018), Independent Power Plants: A panacea to the Growth and Sustainability of Manufacturing Industries in Nigeria, International Conference on Mechanical, Material and Renewable Energy.

[15] Okedu, K.E., Kenu S., Idowu K., Uhunmuwangbo R. (2018), Impact of the Independent Power Producers and National Integrated Power Projects on the Deregulation of the Nigerian Electricity Sector, Journal of Sustainable Development in Africa, Vol.20, No 1.

[16] Opara, S. (2014), 90% Power licenses Idle due to Gas Shortage, The Punch, June 13, p.29.

[17] Uwandu, E. (2019), How we Generate 24-hour Power Supply, Vanguard, Thursday 12, p.38.

[18] Amoda, O. (2016), Power Distribution Demand Side Management in Developing Economies, 13th DEEEAL Distinguished Lecture, The Nigerian Institution of Electrical and Electronic Engineers.

[19] FRN (2012), Investment Opportunities in the Nigeria Power Sector, Federal Republic of Nigeria.