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Draft Road Map to Total Energy Access in Nigeria Using Power Per Capita Model (vol1)

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ABSTRACT
In the past decades, Nigeria has been experiencing epileptic power supply and grid collapse. These problems are caused as a result of the centralization of the National power grid without taking into consideration the increasing population. It should be noted that power demand increases with respect to population increase. To tackle this problem, the National power grid has to be decentralized and mapped to cater for the power needs using sub-regional power cluster mini grid systems within Nigeria with respect to having the capability for grid expansion taking into consideration the increasing population. Thus, there is need to divide the region of the country with respect to the power per capita for each demographic region. Before this division, this work determined the power per capita comparison with Nigeria and the United States of America. The USA and Nigeria Power per capita was estimated at 3,462.15watts/person, and 1.339 Watts/person respectively. The power gap was exemplified using the Power per capita comparative % ratio and the power deficit of 0.0386% and 3460.811Watts/person respectively with USA having the higher advantage. These power gap values demonstrate the contrast in level of development within the two countries. The trend in this research work highlights the theory that the more increase in the population with the same supply energy constraint, the lesser the power per capita will be and thus the more pressure on the grid.
Thus the power capita status of Nigeria gives us the road map to the solution of exploiting and harnessing untapped energy resources with good efficient energy management capability and thus improving the energy access in Nigeria.
KEYWORDS: power per capita, power cluster, national grid, paradigm shift, decentralization, University of Lagos (UNILAG)

AIM
The aim of this work is to first determine the power per capita of USA and Nigeria and design a model in subsequent volume that gives improved energy access to all regions of Nigeria**.**

OBJECTIVE
- Determine the state of the power per capita with respect to the Population –

I. INTRODUCTION

For several years, Nigeria has continually witnessed recurrent grid failures due to power over load or disturbances within the grid network. The major reason for the recurrent system collapse is attributed to high population rate increase which results in additional connections to the fragile electricity grid network, thus leading to overload of the system. Thus, there is a need to decentralize the grid systems by exploiting the power resource potential in different sub-segments of the grid network which can individually form individual smart grid systems in strategic locations across the nation to ensure availability, continuity of power supply, robustness and expansion of the decentralized grid systems to take care of their respective demographic power needs.

This is an innovation as there have been no similar detailed work executed in this area of any known literature.

Due to the fact there has been grid collapse in recent months, which is caused by the strain on the network as a result of population growth, there is a need to design the decentralized power grid systems with respect to the energy use per capita, thus creating a well robust power grid system that can also be expanded.

This work in fig2 plotted Composite Plot of Nigerian Power Production/Demand against time in order to understand and highlight the power needs and deficit of the country which will help meet the overall objective of determining the power per capita of the Nigerian power grid system. This work also demonstrated a

comparison between USA and Nigeria power needs to show us the work which is needed to be done for us to upgrade the Nigerian electricity grid to those of the first world countries.

The first part of this study determined the Power per capita **for Nigeria and USA.** This helped us determine the power per capita deficit and comparative percentage ratio indicating the power gap between the two countries. This will helped us understand the situation of power gap challenges between the two above mentioned countries and how to improve on the power access with respect to Nigeria.

PROBLEM STATEMENT/JUSTIFICATION

If we are having the same distributed power what happens to the newly added citizens due to pro-creation. Over the years, the Nigerian electricity grid has witnessed limited capacity improvements despite the huge amounts of money provided for upgrade. In fig1 ~~below~~; between 1999 and 2005; only 9500 GW of House hold electricity has been consumed from the grid and off grid (Nigeria Energy Sector, 2015). As such, the wheeling capacity has remained almost static or dwindling. Within the period, Nigeria's population has also increased leading to an increase in demands from new households. The masses have to compete for the same static or dwindling energy resource.

This has been identified as a major reason of the grid collapse that occurred in May 2019. Nigerian population continues to increase at an exponential rate yet the grid capacity has only been improved minimally leading to dwindling power supply at the distribution stage.

Thus, there is a need for energy planning taking cognizance of population increase. This is the key to solving the energy problem. Fig 1 below was highlighted to see the consumption energy needs of the masses which will be tied to energy demand.

Population ≡ power demand (1)

There must also be understanding of production and against power demand as in fig2 below.

Also comparing fig 1 and fig 2 the power demand and consumption margin as at 2010 matches that is if the necessary consumption from energy to power is undertaken.

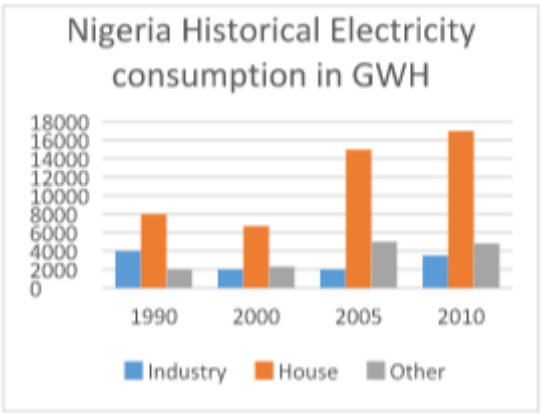

Fig 1 Historical Electricity consumption in Nigeria from 1990 through 2000 to 2010 (Nigeria Energy Sector,2015)

The minimum daily energy consumption was highlighted in the table 1 below.

In table 1 and 2 Below considering The University of LAGOS region with respect to its population, there has been a steady improvement in energy access in University of Lagos with good power per capita. This work highlights the effort for the energy management team of the University of Lagos. In the result and analysis, this work will compare table 3 and table 4 below and indicate the power gap between University of Lagos and the entire Nigerian country and will also compare it to the USA determined data.

Table 1 University of Lagos (UNILAG) case study minimum monthly energy consumption for UNILAG (Oluwatosin et,al, 2016)

Month/year	Min. Daily Energy Consumption (kWh)	Quantity of diesel (liters)	Base load on campus (kW)
Sept.2010	22,220	5332.8	925.8
Oct.2010	38,660	9278.4	1610.83
Nov.2010	44,310	10634.4	1846.25
Dec.2010	30,240	7257.6	1260
Jan.2011	33,720	8092.8	1405
Feb.2011	29,690	7125.6	1237.08

Table 2 UNILAG case study maximum daily energy consumption for UNILAG (Oluwatosin et,al,2016)

Max. Daily Energy Consumption (kWh)	Quantity of diesel (liters)	Peak load on campus (kW)
98,590	23661.6	4107.92
128,720	30892.8	5363.33
145,320	34876.8	6055
96,330	23119.2	4013.75
211,310	50714.4	8804.58
155,070	37216.8	6461.25

After determining the lowest base load and highest peak load for optimal design the **UNILAG power per capita using population 2013 demographic at 103,973 people in table 3 below.**

Table 3. UNILAG power per capita using population 2013 demographic at 103,973 people (Oluwatosin et,al,2016)

S/N	**Power Properties**	**Base Load (Kw)**	**Peak Load (Kw)**
1	Consumption Load	925.8kw	8804.58kw
2	Power Per Capita Month	8.90423kw/ Person	84.681kw/ Person
3	Power Per Capita Daily	0.296807kw/ Person	2.8227w/ Person

In the next fig2 the Composite Plot of Nigerian Power Production/Demand against time was extrapolated

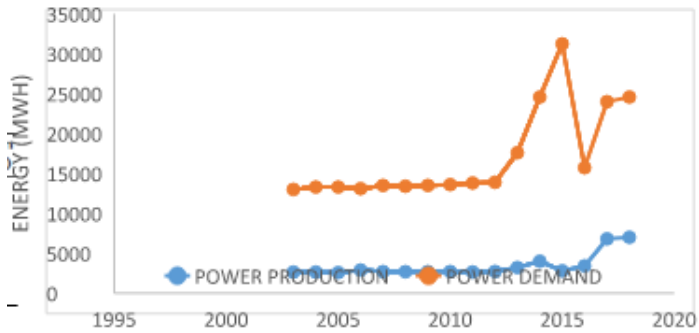

Fig. 2 Composite Plot of Nigerian Power Production/Demand against time

II. METHODOLOGY

In the design of the power cluster system with the view of power per capita; Nigeria and USA power capita was calculated so as to determine the power consumption per person in the two respective countries. This will highlight the disparity between the two national grids and emphasize the need to decentralize the system into a set of mini girds which has already being executed in USA.

In this research work the power used by a single person in the demographic country region is calculated. This is known as the power per capita. This helps us see the contrast and disparity when compared with first world countries like the USA. The power per capita will be compared.
Firstly, obtaining the power per capita is key as at October 16, 2019.
We also compare data from the USA.

Nigeria's power per capita
Total Power distributed=269,282,000Watts (This Day, 2019)
Current population and counting=201,000,000 people. (World Bank, 2019)
Power per capita = =
=1.339Watts/person (2)
For United States of America, the estimated population is 328.2 million people (World Bank 2019) and the distributed power is 1.13628TeraWATT
The power per- capita= Total power distributed/US Population (2019) = =3462.15 Watts /person (3)

Comparison of Nigeria and USA power per-capita

To compare data we divided the Nigerian power per capita by the USA power per capita and get the percentage. This gives us the power gap between the two countries in question.
Power per capita comparative % ratio = = (4)

To understand and dissect the power gap subject, this work calculated the power deficit of the power per-capita between the two countries
Power per capita deficit = USA power per-per capita – Nigeria power per-capita = 3462.15 Watts/person -1.339 Watts/person= 3460.811Watts/person (5)

Comparison of UNILAG and Nigeria power per-capita. Considering table 3 &4 data

Power per capita comparative % ratio = = (6)

It can be seen that the UNILAG Power per-capita is higher than that compared with Nigeria. Nigeria power per-capita is 47.437% of UNILAG power per-capita with a deficit of:
Power deficit = UNILAG power per capita- Nigeria power per-capita= 2.8227-1.339= 1.4837 Watts/person. (7)

III. RESULT

Table4 of extrapolated Power per capita in USA and Nigeria (Us Energy Information Administration, 2020)

S/N	TITLE	USA	Nigeria@ OCT 2019
1	POPULATION	328,200,000	201,000,000
2	TOTAL DISTRIBUTED POWER	1.13628Terawatt	269,282,000W
3	POWER PER CAPITA WATT/PERSON	3,462.15watt/person	1.339 Watts/person

IV. RESULT AND ANALYSIS

This above result tells us the power gap between Nigeria and USA & Nigeria and UNILAG indication that the power consumed by a Nigerian individual is about 0.0386% of the power used by USA individual.

The deficit 3460.811Watts/person for USA power per-capita shows the power gap between USA AND Nigeria for the power per-capita value. In the methodology, this work also highlighted the power per-capita comparative ratio and power deficit of 47.437% and 1.4837 Watts/person between Nigeria and UNILAG with UNILAG having the higher advantage in the terms of power situation. These deficits are matters of serious urgency of the power gap and a disparity in standard of living as a result of the accessibility to power for an individual; between the two countries. And the UNILAG region within Nigeria.

V. RECOMMENDATION

Due to the unfavorable result of Nigeria Power per Capita situation there is need to work in improving the power per capital of Nigerians to at least 500-700 W/person which is realistic to our technical knowhow; if and only the proper leaders are employed and empowered. Thus, the power per capita trend highlights the theory that the more increase in the population with the same supply energy constraint, the lesser the power per capita will be and thus the more pressure on the grid. Thus, it is recommended by this research work that Nigeria works on increasing the power per capita by 600% to compete minimally with other conventional power per capita standards of first world countries including the USA.

VI. CONCLUSION

It is therefore expedient that the National grid is decentralized in other to cater for the demand in rising population and let the mini grid replace the national gird in the six geo-political zones in with the initiative of

population orientation. Also, in subsequent work, the Nigerian region will be mapped at strategic location where the energy resource potential in the regions will be exploited to form a series or power cluster of mini grids

REFERENCES

[1]. Oluwatosin M. Dada[1, *], Ilesanmi A. Daniyan[1], Temitayo M. Azeez[1], Olalekan O. Adaramola[2]2016,Audit of Electricity Generation in University of Lagos, Nigeria, International Journal of Energy and power Engineering, Vol.5,No.2,pp. 29-33.URLhttp://article.sciencepublishinggroup.com/html/10.11648.j.ijepe.20160502.11.html

[2]. Nigeria Energy sector 2015, Mobilizing Renewable Energy Investments **Error! Hyperlink reference not valid.**//www.get-invest.eu/market

[3]. information/Nigeria/energy-sector/>

[4]. World Bank 2019, Nigerian population & united States status census Bureau 2019

[5]. This day 2019, "Discos overall power distribution level plunges to 2,962MW says report"

[6]. <https://www.thisdaylive.com/index.php/2019/09/05/discos-overall-power-distribution-level-plunges-to-2962mw-says-report/>

[7]. Us Energy Information Administration (2020), Electricity generation, capacity and sales in the United States.<https://www.eia.gov/energyexplained/electricity/electricity-in-the-us-generation-capacity-and-sales.php>

Igwilo O.C, et. al. "Draft Road Map to Total Energy Access in Nigeria Using Power Per Capita Model (vol1)." *IOSR Journal of Engineering (IOSRJEN),* 11(03), 2021, pp. 33-37.