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Least Square Regression of Power Generation and Gas Consumption in Nigerian Integrated High Voltage Generation and Transmission Grid

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Abstract **- This paper is aimed at studying the power generation and gas consumption in Nigerian Integrated High Voltage Generation and Transmission grid using least square regression method. It reviews the power generated in Nigeria, high voltage transmission and current integrated power systems in Nigeria and gas consumption curve have been developed for the Nigerian thermal power plants. The regression model feeds the data since all the R^{2}'s are near 1**

I) INTRODUCTION

Nigeria is a vast nation with an aggregate of 356, 667 sq. miles (923,768 sq. km), of which 351,649 sq miles (910,771 sq. km or 98.6% of aggregate zone) is land.The country is made up of six Geo-Political Zones subdivided into 36 states and the Federal Capital Territory (FCT). Moreover, the vegetation spread, physical gimmicks and area landscape in the country shift from level open savannah in the North to thick rain timberlands in the south, with various waterways, lakes and mountains scattered everywhere throughout the nation.These national physical and political qualities themselves present difficulties for the powerful procurement of force needs to all alcoves and corners of the nation. To give satisfactory power to guarantee that Nigeria is among the industrialized countries, three basic activities must be viably accomplished.

- Satisfactory power must be generated
- The power should viably be transmitted to all parts of the nation.
- Finally be efficiently distributed to the consumers.

The Electric Power Sector is a standout amongst the most imperative parts to national improvement. The power sector is critical to the developmental reform of any country. To discuss the electric power sector in Nigeria in a realistic way, an appraisal of its development since independence is necessary in this study. Electricity supply in Nigeria dates back to 1886 when two small generating sets were installed to serve the then Colony of Lagos. By an Act of Parliament in 1951, the Electricity Corporation of Nigeria (ECN) was established, and in 1962, the Niger Dams Authority (NDA) was also established for the development of Hydro Electric Power. However, a merger of the two was made in 1972 to form the National Electric power Authority (NEPA), which as a result of unbundling and the power reform process, was renamed Power holding Company of Nigeria (PHCN) in 2005 [1].

A power system is known as an adaptable moderately shabby and savvy method for providing energy in any Nation or community. It comprises of three main hierarchical stages or subsystems known respectively as generation, transmission and distribution.It is compelling and irreplaceable machinery for the quick modern and economic development of any country.

a) Power Generation In Nigeria

Powergeneration in Nigeria throughout the most recent 40 years has changed from gas-fired, oil fired, hydroelectric power stations to coal-fired stations with hydroelectric power systems and gas fired systems outweighing everything else.

There are 21thermal stations in Nigeria and as on October 20 2014, the electricity supply across the country was really poor as it dropped by 1000megawatts, Figures discharged by the Federal Ministry of Power demonstrated that the nation's peak power as of October 15, 2014 was 3,513.5mw, against a top demand of 12,800mw, which implies that the nation is as of now generating around 2,500mw[2].This is as result of non-availability of gas bringing about low gas consumption and less power generation.

Gas use is an essential objective of Nigeria's petroleum and vitality strategies. This is on account of, with a demonstrated store of 260 trillion cubic feet of characteristic gas, Nigeria's gas store is triple the country's raw petroleum assets. Up to this point, related gas experienced amid the typical course of oil creation has been to a great extent flared. Nigeria is reputed to be the largest gas-flaring nation on the planet. By not completely harnessing its gas assets, Nigeria loses an expected 18.2 million U.S. dollars every day.In this manner Nigeria power generation is low at a few focuses at an aftereffect of inadequate gas generation,thisdemonstrates that power era is high reliant on gas consumption.

b) Review Of Current Nigeria Integrated Power System

Presently, about 40percent of Nigeria's total population has admittance to open power supply because of deficient transmission and distribution networks[1]. Also ageing infrastructure,frail and radial network configuration, and overloaded transformers result in successive framework breakdown, with high transmission and distribution losses and poor voltage profile. At present, with a percentage of the finished integrated power projects, the Nigeria national grid is an interconnection of 9,454.8KM length of 330kV and 8,985.28km length of 132Kv transmission lines with seventeen power stations. [2].The current projection of the power generation by PHCN is to generate 26,561MW as envisioned in the vision 2020 target; presently the active power generating stations with installed capacity of 11679.6MW and 3754MW is available. The generating stations are sometimes connected to load centers via either really long or ineffectual transmission lines which has extremely high transmission losses up to 25% compared to 3% in the US, n0.4 in South Korea and 0.5 in Japan[1].

c) High Voltage Transmission

Electric-power transmission is the MASS transfer of electrical energy, from generating power plants to electrical substations found close request focuses.This is unique from the local wiring between high-voltage substations and clients,which is commonly alluded to as electric power distribution. When transmission lines are interconnected with each other, become transmission networks. The combined transmission and distribution network is known as the "power grid".

The aim of this work therefore is to develop a gas consumption curve for the Nigerian Integrated high voltage generation and transmission grid.

Ii) Materials And Methods

Nigerian Integrated High Voltage Power System (NIHVPS) acquisition

The data that was collected from Nigerian Integrated High Voltage Power System (NIHVPS) is considered a core of this section of the report.it is very important to give en explanation of the nature of this data and how it was collected and used. The data received was for the years 2011-2014.The data collected consists of;

- Daily total power generation from the 21 thermal stations from January 2011 to July 2013.
- Daily gas consumption of the 21 thermal stations from January 2011 to July 2013.

Firstly, the data was essentially gathered, sorted out and preserved in the operation segment of NIHVPS. The head of the operation has affirmed that 95% of the information is exact and subsequently dependable for research purposes. In spite of the fact that it was at first hard to acquire any data from the operation area because of confidentiality reasons, promises of secrecy were made and all vital data were gathered.

d) NIHVPS data manipulation

The data got from NIHVPS operation division was fed first to an excel spread sheet.Consistently, in the years 2011-2013, a row had been allocated that contains the date, total power generation and the total gas consumption , To guarantee precision, the gas consumption was recalculated by dividing the power generated in each 21 thermal stations by ……..to get the gas consumed for each day. The gas consumption (vertical axis) was plotted against the power generated (horizontal axis) to get the curve fitting using least square regression. Least square regression method is used for curve fitting to get the gas consumption curve of the 21 thermal stations in the NIHVPS

a) Modeling Of Polynomial Equation For Each Generating Unit

Least Square regression was used to generate polynomial equations for 19 out of 21 thermal stations that generated power

Least Square Equations

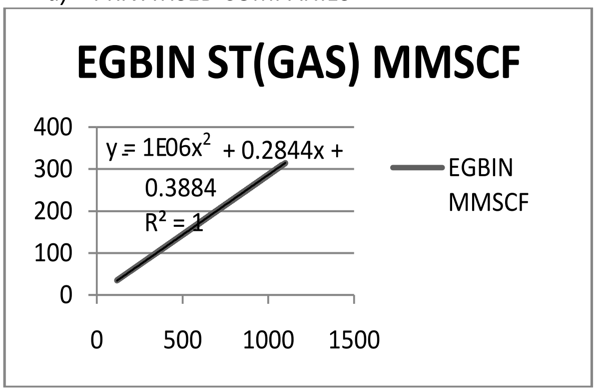
$$\sum F\,i = aN + b\sum p + c\sum p^2 \qquad \text{(i)}$$

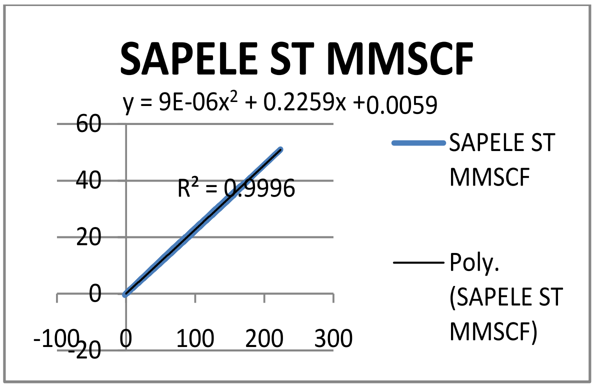
$$\sum F\,ip = a\sum p^2 + b\sum p^2 + c\sum p^3 \qquad \text{(ii)}$$

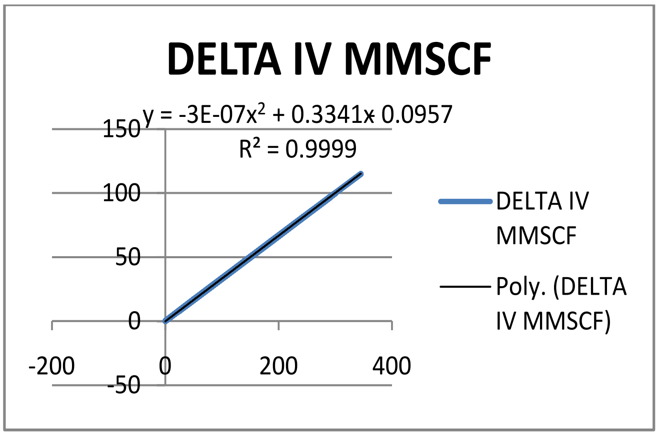
$$\sum Fip^2 = a\sum p^2 + b\sum p^3 + c\sum p^4 \qquad \text{(iii)}\ [5]$$

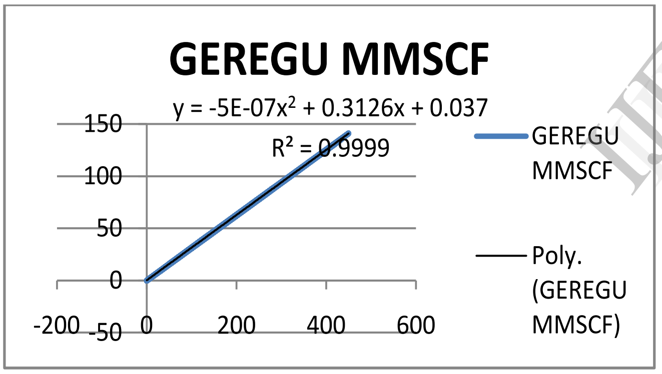
III) RESULTS

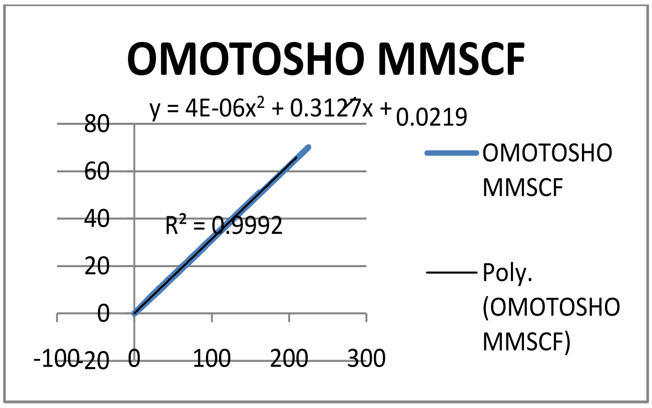
a) PRIVATISED COMPANIES

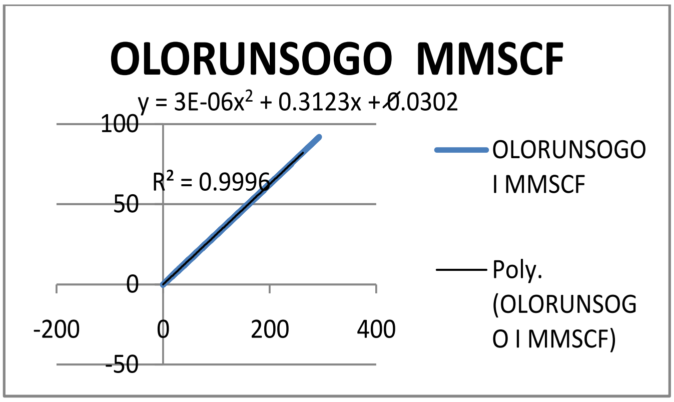


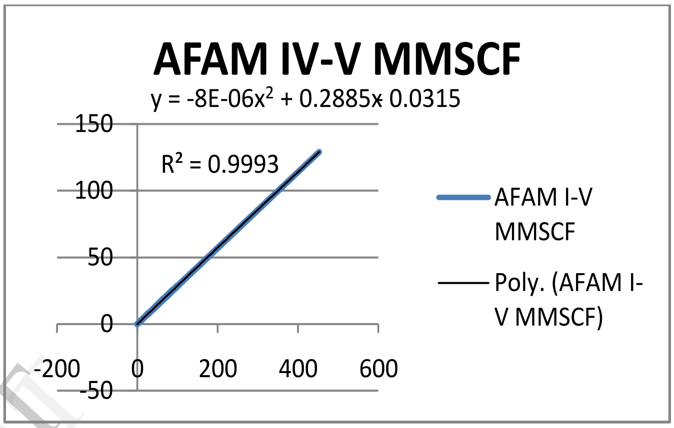




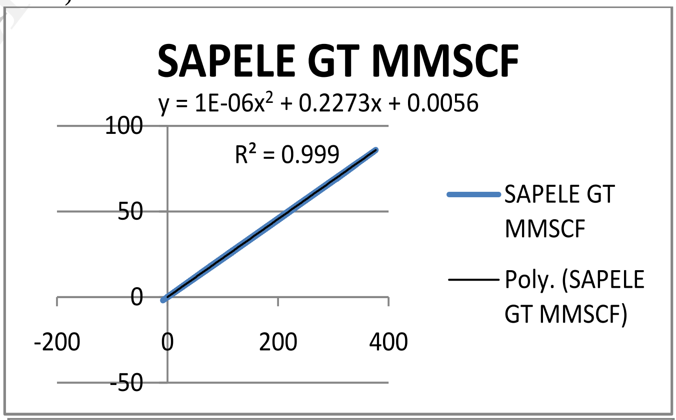


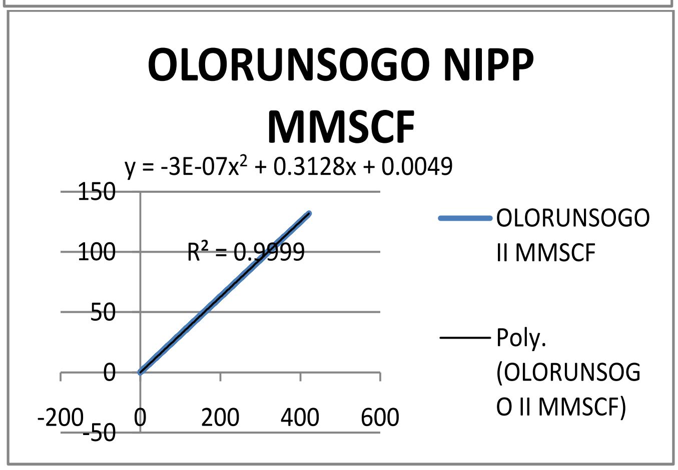


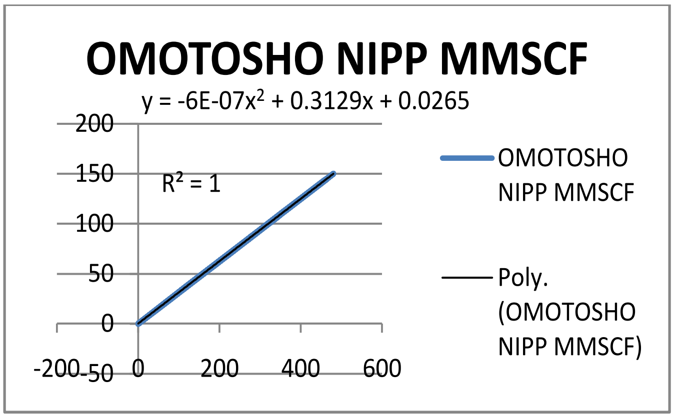


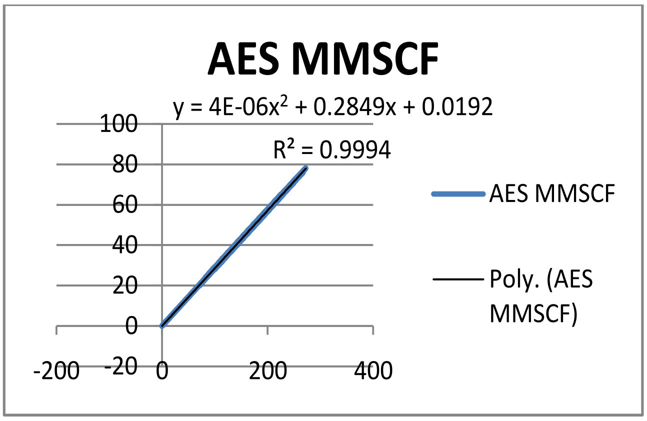


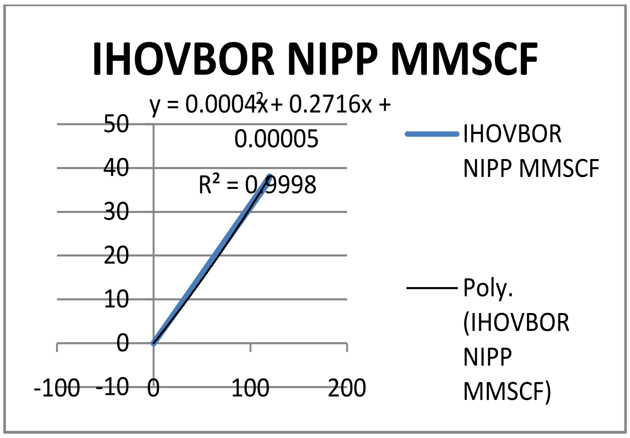
b) NIPP-THERMAL STATIONS

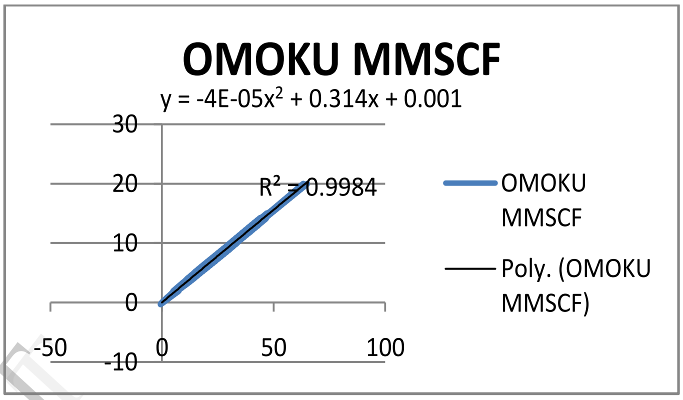




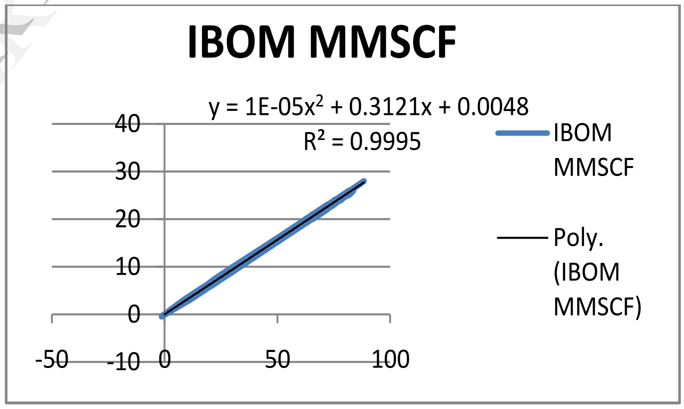


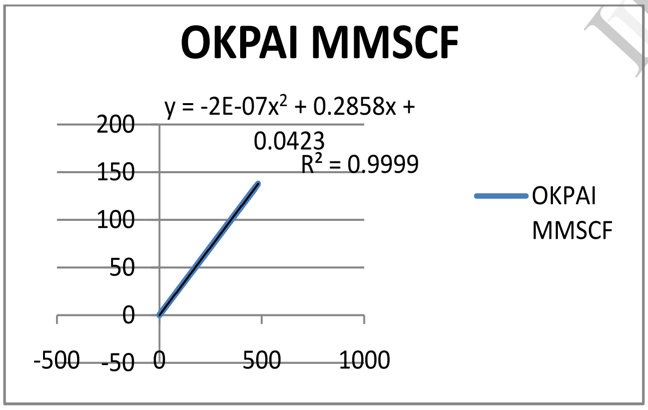


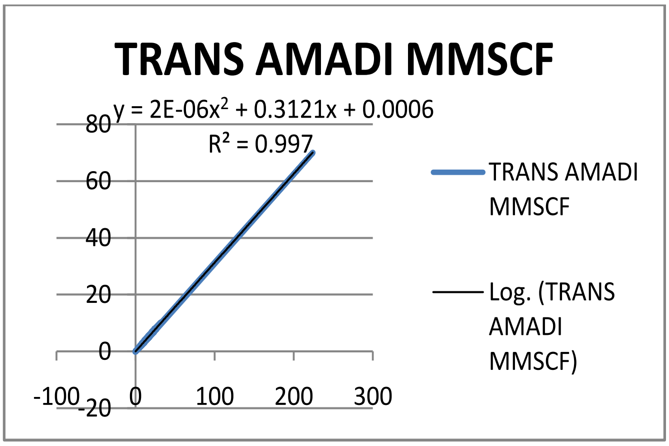


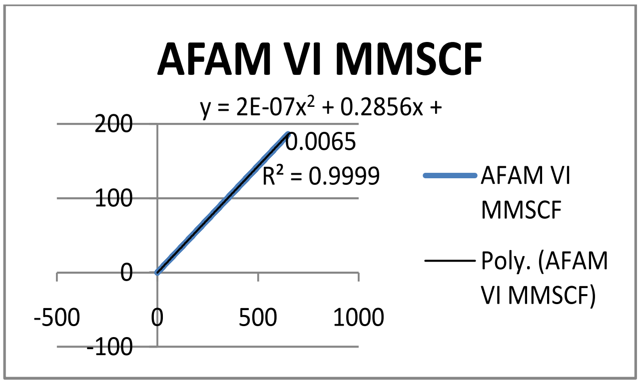


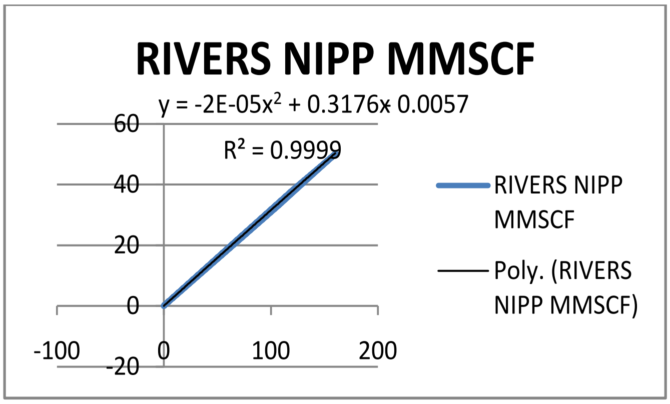
c) IPP-THERMAL STATIONS

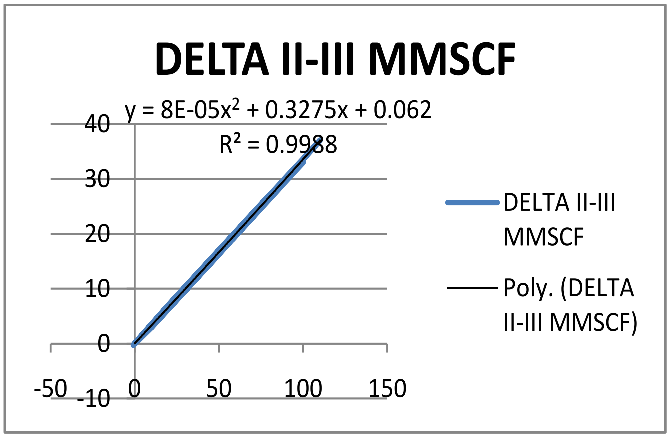












The curve fitting is almost perfect because the R^2 values are all close to one or 1.

IV) DISCUSSION

The gas consumption curve for the different thermal stations in Nigeria is as shown on the plot

V) CONCLUSION

This is the first time that real data from Transmission Company of Nigeria, Oshogbo has been used to develop a gas consumption curve for the Nigerian power system;more papers would come from this for economic dispatch of the Nigerian system. The curve fitting is almost perfect because the R^2 values are all close to 1 and The regression model feeds the data since all the R^2 ' s are near 1.

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