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Analysis of Nigeria Power Generation Sustainability through Natural Gas Supply *(pp. 434 – 443.)*

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Abstract: The use of natural gas as a fuel in heat engines for the generation of electricity is a technology that has been for decades, which operates on the Brayton cycle principle. In a bid to meet the energy needs of Nigerians despite its unparallel gas potentials of about 187 TCF of proven gas reserves, Ughelli Power PLC was put under study. The study reveals that there was an uneven energy generation despite the large quantity of gas supplied. Nigeria's total installed capacity is at 6000 MW with its present output at 3000MW. The study of Delta four power plants reveals an average consumption of 1,021,490,501.43 scf of gas indicating 82,461.24 MWH (178.1MW) energy generation. A total average power generation of 30.5% out of the installed capacity was found, resulting in 2.9% of National contribution. It is strongly recommended that Proper gas conservation practices should be enforced.

Key words: energy, power plant, installed capacity, natural gas

INTRODUCTION

For decades now, there has been an issue which has captured the attention of many, both government and the public in Nigeria. This issue is of great importance as its availability will bring about job creation, development, wealth creation and an overall boost to the Nigerian economy. But over the years, its unavailability has caused a real deal of harm as it has led to the death of lots of dreams, aspirations and ideas, what a pathetic situation. This long standing issue is the issue of power and its generation.

Owing to various changes in the Federal Government policies on the Electricity industry from 1973 to 2009, Ughelli Power Plc has on various occasions changed its name and out-looks. The station has changed from installed capacity of 72MW in 1964 to six units of gas turbines of 20MW each in 1975. In 1978, additional six units of GE gas turbines were added to Delta Power Station to boost the installed capacity to a total of 312MW.The Station was upgraded in 1991 with the addition of 600MW gas turbines.

Power here refers to electricity, and electricity is a physical phenomenon associated with stationary or moving electrons and protons. Electricity is also energy made available by the flow of electric charge through a conductor. The fundamental principles of electricity generation were discovered during the 1820s early 1830s by the British scientist Michael Faraday, and his basic method is still used today (Wikipedia, 2011).

Electricity generation is the process of generating electric energy from other forms of energy. Electricity is generated by the movement of a loop of wire, or disc of copper between the poles of a magnet (Presidential Task Force on Power, 2011).

Electricity is often generated at a power station by electromechanical generators primarily driven by heat engines fueled by chemical combustion or nuclear fission, but also by other means such as the kinetic energy of flowing water and wind. There are many such as photovoltaic and geothermal power. Natural gas is a fuel used by heat engines which produces the energy with which electricity is generated from the turbine. Natural gas is a gas consisting primarily of methane, typically with 0-20% higher hydrocarbons. It is found associated with other hydrocarbon fuel in coal beds, as methane cathrates, and is an important fuel source and a major feedstock.

Before natural gas can be used as a fuel, it must undergo processing to remove almost all materials other than methane. The bi–product of that processing includes: Ethane, Propane, Butane, Pentane and Higher molecular weight hydrocarbons, Elemental sulfur, Carbon dioxide, Water vapor, Helium and nitrogen sometimes.

After natural gas has been processed and transported through pipelines to the plant, the gas mixes with compressed air in the compressor and burns in the combustion chamber. The product of the combustion is the energy required by the turbine for power (electricity) generation .The product from the turbine (i.e. electricity) is directly proportional to the energy produced by the combustion of the fuel (natural gas) in the combustion chamber.

This implies that natural gas (the fuel) for power generation is of great interest and importance, because of the role it plays in the generation of power. And for a nation like Nigeria one of the world's largest/leading producer of natural gas, it is deplorable to note that even with this technology and her large natural gas reserves of about 187 TCF, she still suffers from the availability of power (electricity) which is a tool for growth and economic development.

PURPOSE AND JUSTIFICATION

Power generation through gas supply to Delta four gas plants towards targeted total output of 4800MW constant power supply to the nation in the year 2013 realistic or feeble, using Ughelli Delta IV (four) power plants.

PRODUCTION OF ELECTRICITY AT DELTA IV

Ughelli power PLC is one of the thermal power stations in Nigeria, located in the Niger Delta. Ughelli power PLC is one of the largest thermal generating power stations. It has various units ranging from Delta I, Delta II, Delta III and Delta IV. Delta IV operates on natural gas (a gas turbine) and it has an installed capacity of 600 MW.

The gas turbine operates on the concept of the brayton cycle or double cycles (constant pressure cycle). It employs the use of natural gas and compressed air, whose mixture when combust in the combustion chamber releases energy which is channeled to rotate the shaft of the turbine which in turn rotates the blades of the generator thereby generating electricity. Excitation is necessary to produce the required magnetic flux. The natural gas used is supplied by Nigeria gas company (NGC) and the Shell petroleum development company (SPDC) using a tripartite pipeline system. The gas is supplied at a pressure of 19 -21 bars (275.5 – 304.5 Psia) and is passed through a scrubber where further purification of the gas is carried out under the action of gravity, where the impurities settle down at the bottom and the gas is extracted from the top and sent into the combustion chamber where it mixes with the compressed air which is coming from the compressor. The air which is got by suction from the atmosphere is first purified, and it is passed through the compressor where it is pressurized before it gets to the combustion chamber. At the combustion chamber, the mixture of the gas and the compressed air combusts (burns) and releases energy which is channeled to the turbine where it is put to work in the rotation of the shaft which in turn rotates the blades of the generator which then generates electricity.

METHODOLOGY

Procedure for Data Collection

To accomplish this work ,the following processes enumerated were employed in data collection, weekly, monthly and yearly plant status of gas supplied (or Total station Volume of gas consumed, ScF) by Shell Petroleum Development Company (SPDC) and Nigerian Gas Company (NGC) Warri and Energy generated (MWH) by the plant were recorded for a period of about five (5) years.

- **Monthly Status Report**

Table 1: Energy generated and gas consumed in year 2007

Month	Gas consumed (ScF)	Energy generated (MWH)
January	498,943,548.86	207,658.00
February	554,326,987.01	155,416.00
March	79,311,578.45	153,908.00
April	709,533,310.33	104,291.00
May	533,717,916.62	109,793.00
June	669,339,754.22	100,139.00
July	680,114,101.19	130,656.00
August	811,985,041.65	103,874.00

September	804,870,138.00	120,663.00
October	865,012,844.62	123,013.00
November	977,924,669.35	109,748.00
December	997,142,582.43	104,915.00

Table 2: Energy generated and gas consumed in year 2008

Month	Gas consumed (SCF)	Energy generated (MWH)
January	1,515,583,333.00	111,920.00
February	986,903,125.00	72,879.00
March	1,600,042,708.00	118,157.00
April	1,506,767,708.00	112,062.00
May	385,815,625.00	28,491.00
June	603,958,333.00	44,600.00
July	1,611,620,833.00	119,012.00
August	869.632,292.00	64,219.00
September	356,457,292.00	26,323.00
October	116,647,917.00	8,614.00
November	0.00	0.00
December	29,804,288.21	2,018.00

Table 3: Energy generated and gas consumed in year 2009

Month	Gas consumed (SCF)	Energy generated (MWH)
January	1,290,168,750.00	86,289.00
February	1,208,620,834.00	89,252.00
March	1,517,194,792.00	112,039.00
April	1,109,157,292.00	81,907.00
May	1,275,097,875.00	106,074.00
June	1,385,521,250.00	115,260.00
July	826,804,669.00	76,100.00
August	723,855,119.83	64,627.00
September	785,453,270.83	65,341.00
October	1,025,304,958.33	85,294.00
November	1,325,304,958.00	110,250.60
December	0.00	0.00

Table 4: Energy generated and gas consumed in year 2010

Month	Gas consumed (SCF)	Energy generated (MWH)	MW Gen
January	737,373,949.58	63,178.20	136
February	607,950,078.21	33,492.00	115
March	1,096,149,939.00	106,619.00	203
April	1,527,705,195.00	148,595.00	294
May	1,379,915,820.00	134,220.00	275
June	1,870,185,867.00	181,907.00	301
July	1,614,188,967.00	157,007.00	303
August	1,597.615,995.00	155,395.00	255
September	1,126,139,616.00	109,536.00	228
October	1,136,709,512.10	110,564.10	150
November	763,156,341.00	71,416.00	148
December	416,627,244.00	40,524.00	228

Table 5: Energy generated and gas consumed in year 2011

Month	Gas consumed (SCF)	Energy generated (MWH)	MW Gen
January	294,807,675.00	28,675.00	148
February	89,073,744.00	67,024.00	204
March	1,099,151,991.00	85,534.00	141
April	879,375,054.00	106,911.00	151

- **Yearly Report**

Table 6: Gas Consumed and Energy Generation From 2000-2010

Year	Gas consumed (SCF)	Energy Generated (MWH)
2000	14,355,289.82	1,325,301
2001	6,439,001,174.00	2,118,213
2002	48,158,183,257.00	3,432,776
2003	44,126,568,292.00	3,459,012
2004	41,799,273,329.82	3,933,785
2005	37,985,279,000.45	3,263,086
2006	51,570,873,327.67	3,784,058
2007	38,216,355,188.90	2,697,033
2008	22,044,922,892.84	1,510,988
2009	23,165,806,486.40	1,582,697

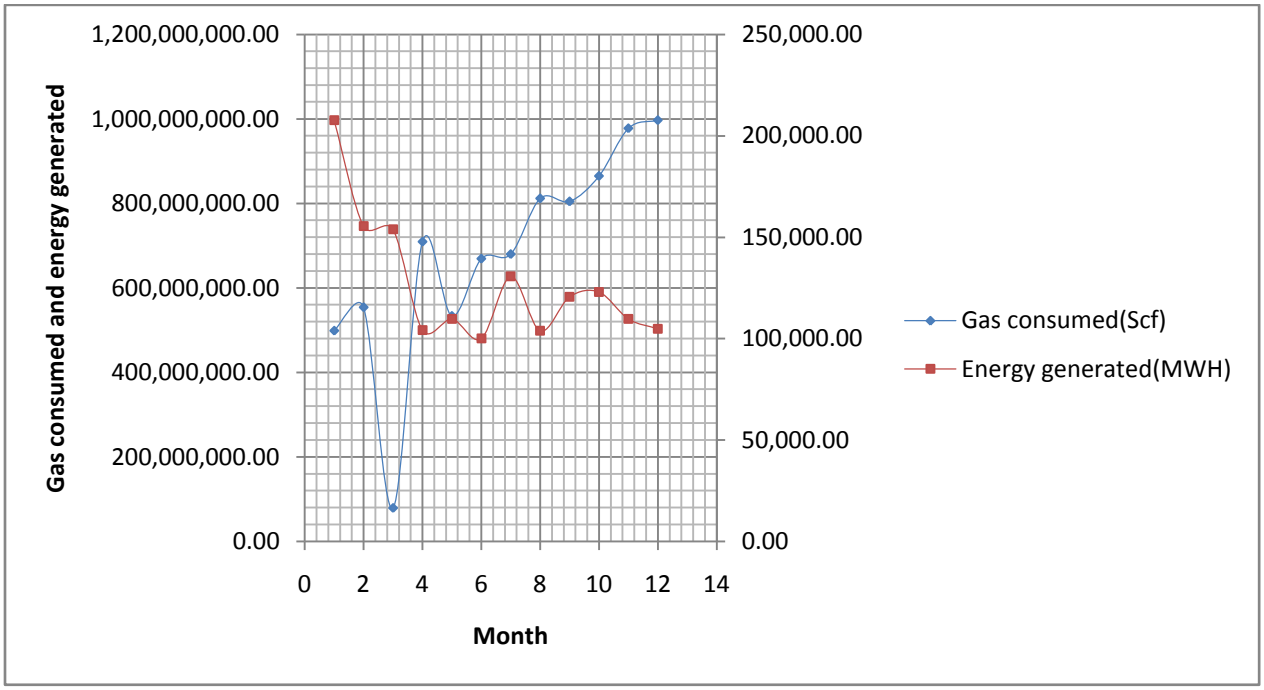

Figure 1: Graph of gas consumed and energy generated in the year 2007.

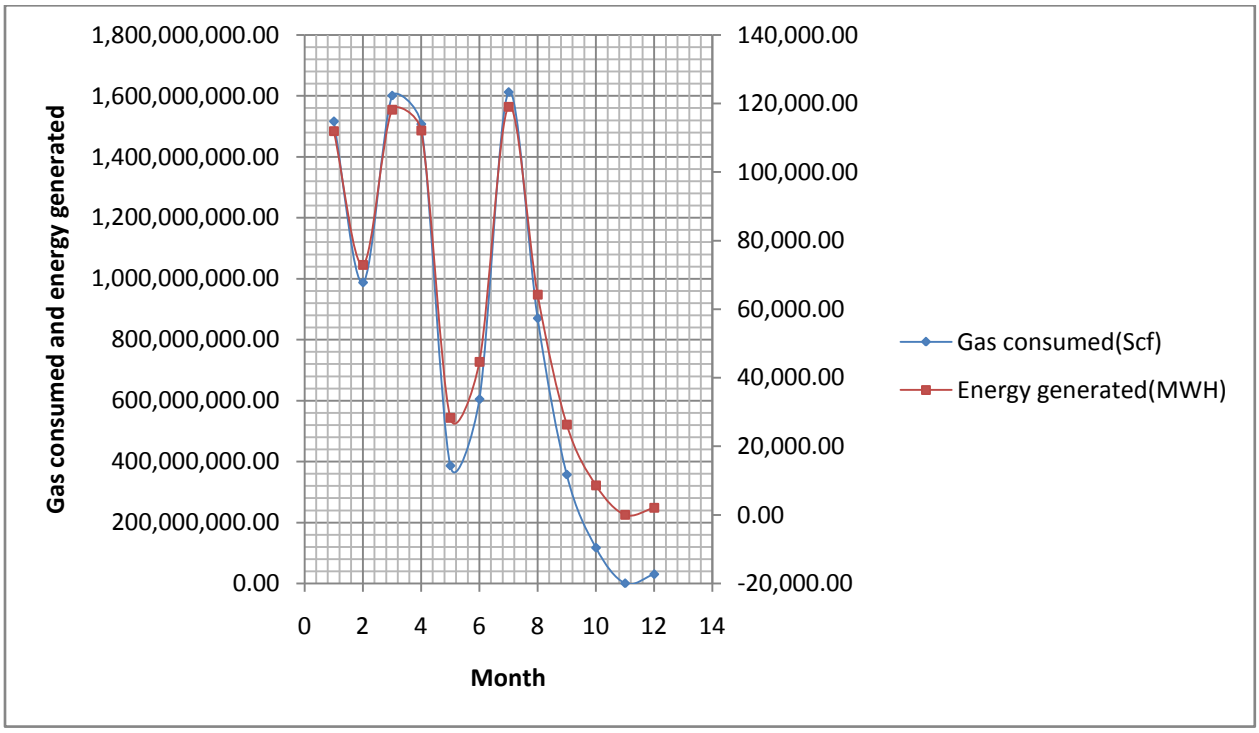

Figure 2: Graph of gas consumed and energy generated in the year 2008

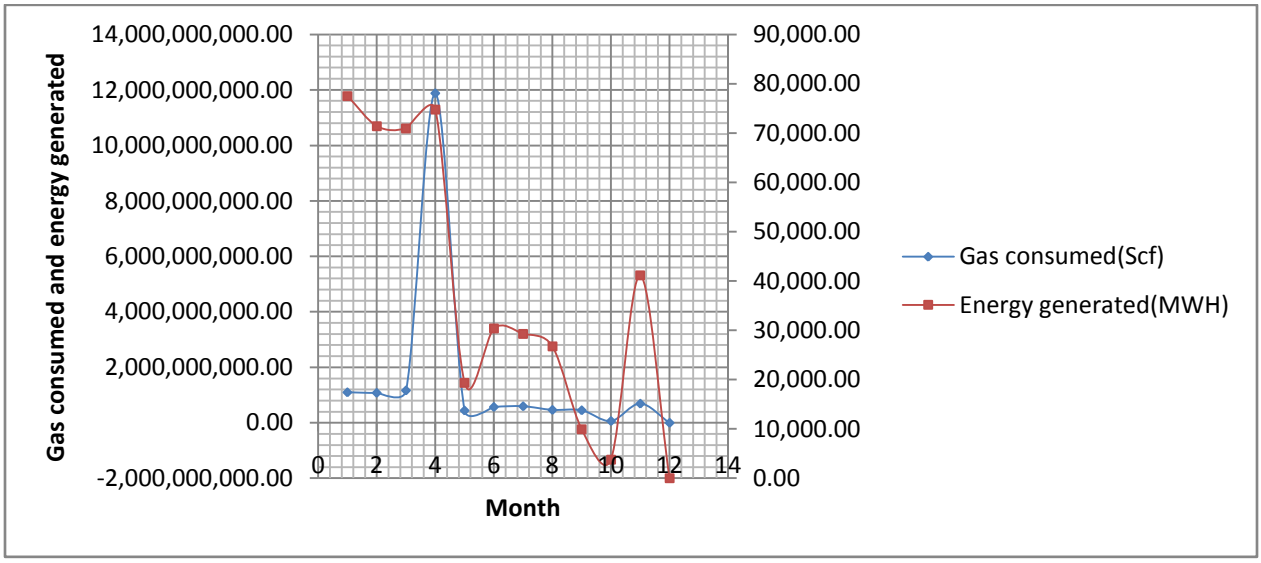

Figure 3: Graph of gas consumed and energy generated in the year 2009

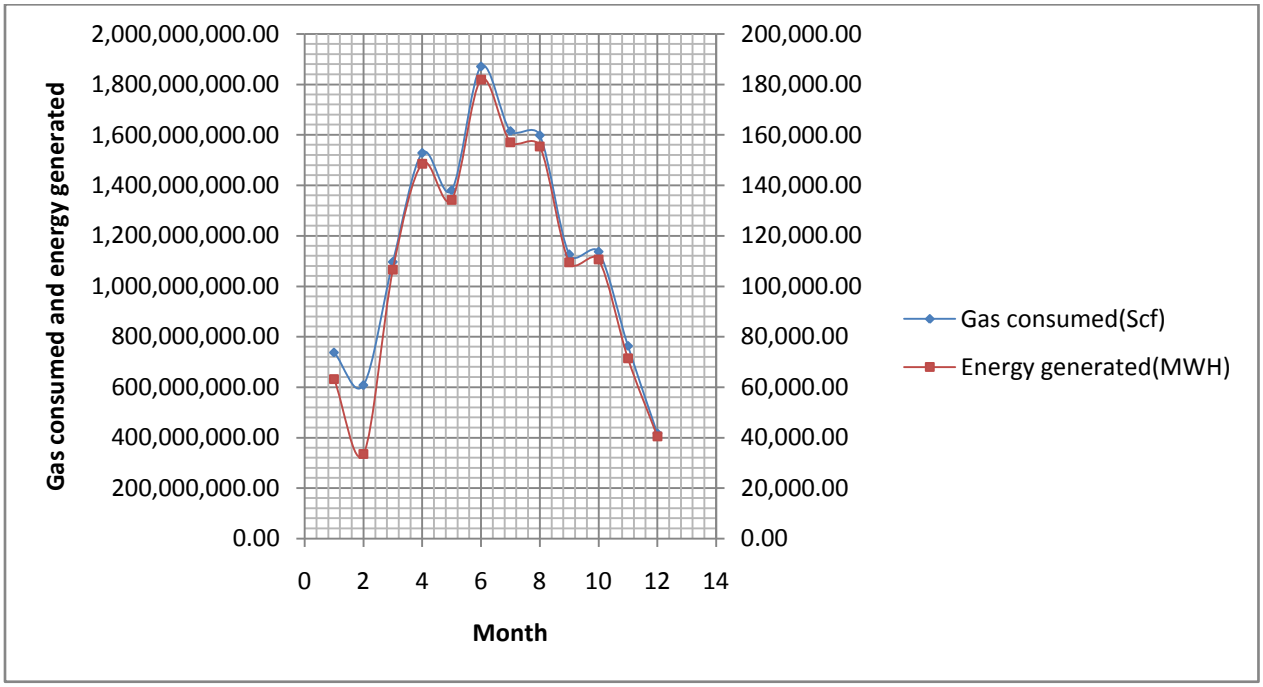

Figure 4: Graph of gas consumed and energy generated in the year 2010

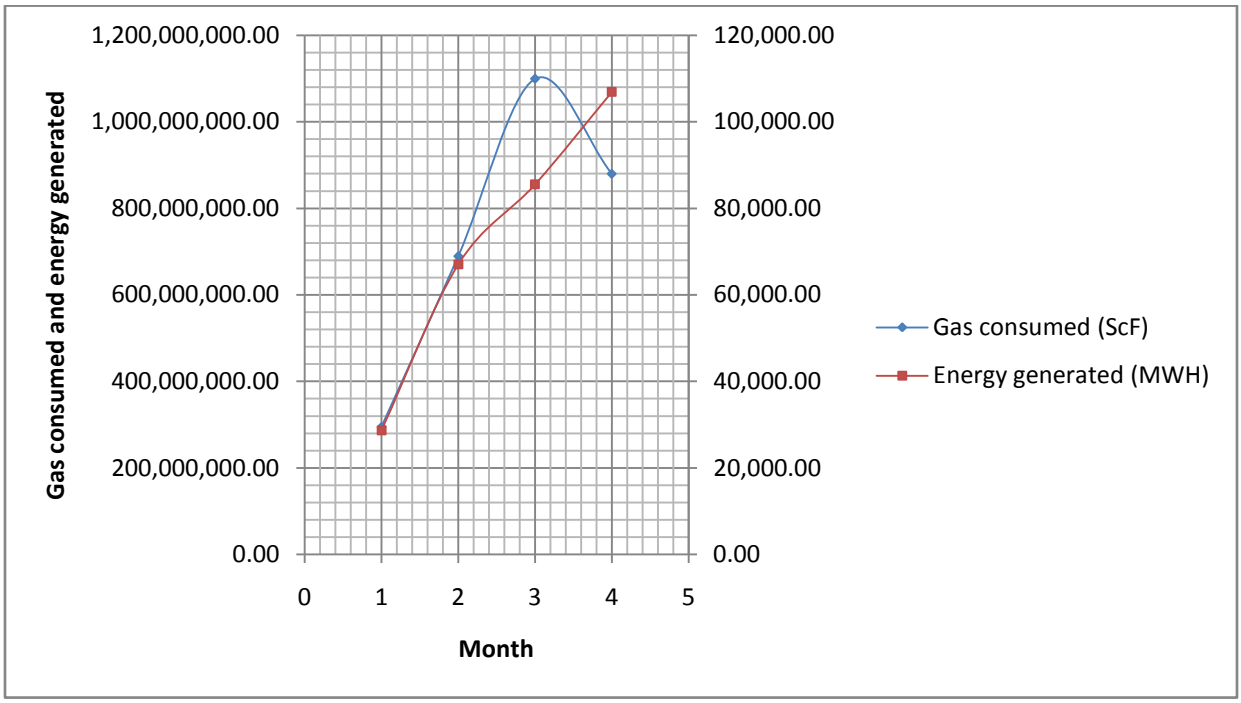

Figure 5: Graph of gas consumed and energy generated in the year 2011

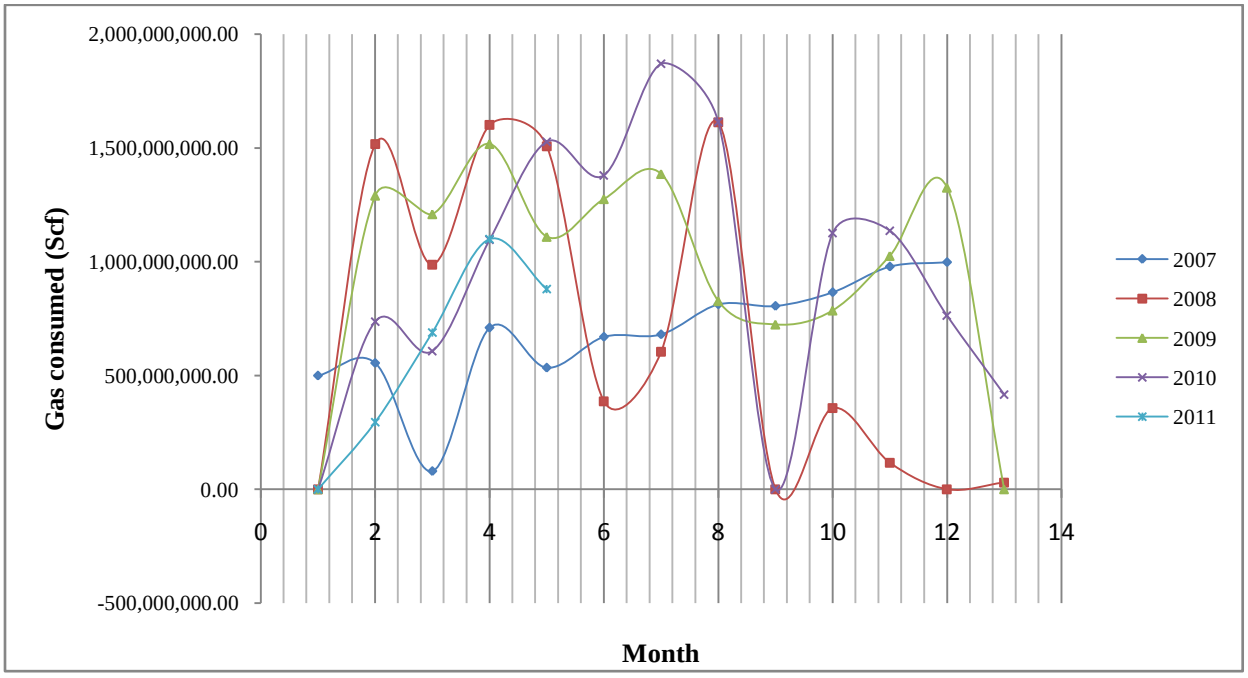

Figure 6: Graph of gas consumed from January 2007 - April 2011

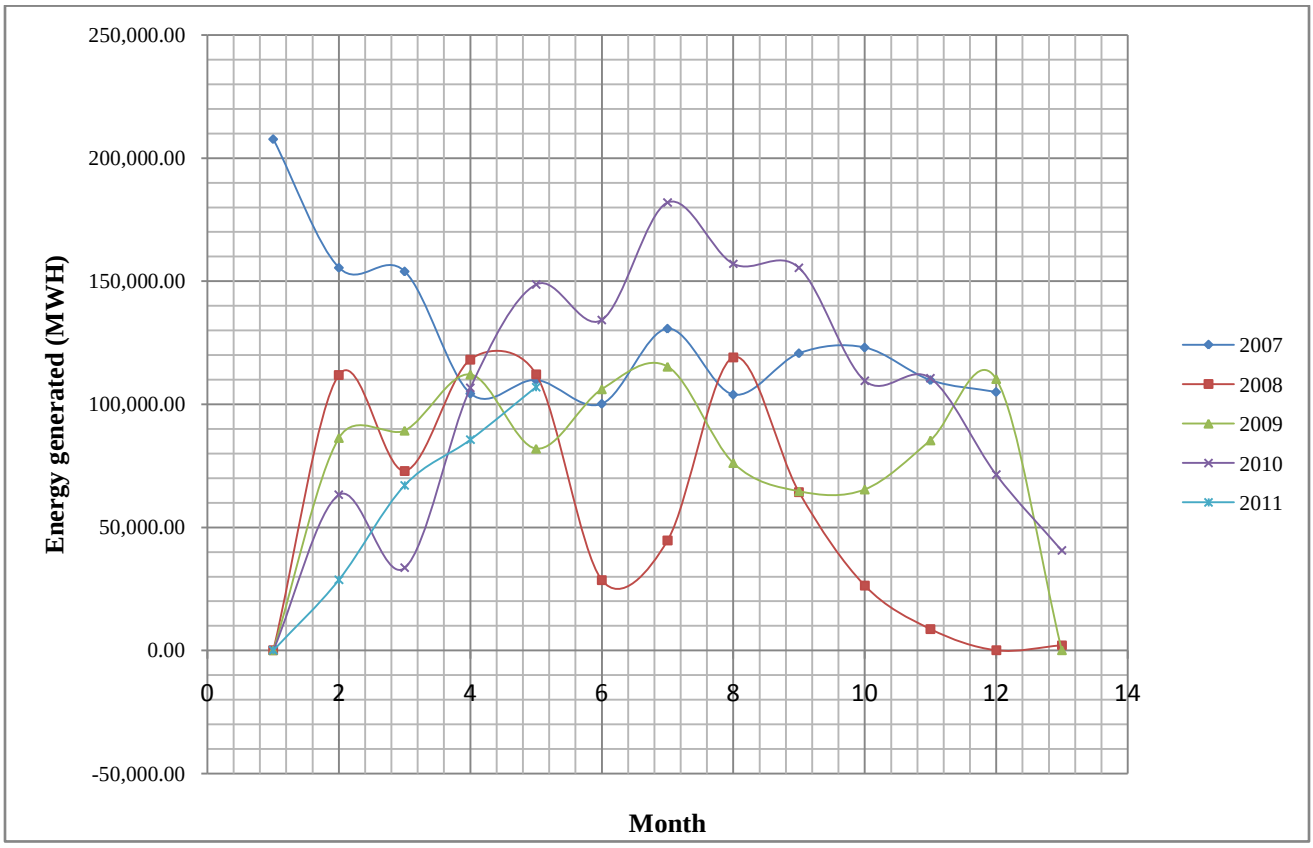

Figure 7: Chart of energy generated from January 2007 - April 2011

DISCUSSION OF RESULTS

In the year 2007, apart from the tremendous increase in the amount of gas consumed by the plant, there was a steady decline in energy generation. The average energy generation was 127,006MWH (274MW) giving 45% of total installed capacity.

The quantity of gas consumed and power generated in the first two (2) months of year (2008) were high but fell towards the end of the year, having a maximum peak on the second and seventh months of 2008 and fell steadily for almost second half of the year, were there was shortage of gas supply to the plant resulting to non-generation of power. The average energy generation was 59,024.5MWH (127.5MW) giving 21% of installed capacity.

Similar pictures could be painted for the preceding years- 2009, 2010 and 2011,resulting in average power generation of 82,702.8MWH (178.6MW), 101,155.8MWH (219MW) and 72,036MWH (127MW) respectively.

In the year 2010 for example, the gas consumed and energy generated rose gradually and fell steadily below the expected power generation for that year. The average power generation for the year 2009 and 2010 was 178.6MW, 219MW of about 29.7%, 36.6% of the installed capacity respectively. And in the first four (4) months of 2011, an average power generation was 127MW which is about 21% of the installed capacity.

In general, it was observed that when large amount of gas was consumed, no equivalent amount of power generation was obtained. In some situations, a low amount of gas was consumed that resulted into a higher value of power generation. There was no definite partten in their gas consumption and power generation.
Throughout the year under consideration (2007-2011), there was constant fall of power generation and gas consumption from year to year.

CONCLUSION

There was no steady or defined pattern for gas consumption and energy generation that suggest that there is an improvement or constant yearly increment in power generation throughout the period under review even though large quantity of gas was consumed. A total average power generation of 30.5% out of the installed capacity was obtained. System process inefficiencies associated with the operating structure in the industry with several point of leakages and losses leading to loss of system sustainability. Therefore, there is no way the Nation can eradicate the epileptic power supply we are experiencing now and in the future, if this attitude is not changed.

The amount of gas supplied from the Nigerian Gas Company and the Shell Petroleum Development Company does not show any sign of regularity and also the nonchalant attitude of those consuming or generating the power has led to the inadequate supply of energy or electricity.

RECOMMENDATIONS

Based on the findings, it is strongly recommended that:-Proper gas conservation practices should be enforced. This can be achieved by ensuring the workability of the Nigerian master gas plan.

For the Nation to attain steady electricity supply there must be a constant rise in power generation throughout successive years achievable through maintaining that:

- There should be a steady supply of gas from Nigerian Gas Company and Shell Petroleum Development Company to gas plant
- The gas supplied should fully be maximized by the Delta four power plants. This is because the large quantity of gas supplied does not commensurate with the energy generated.

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REFERENCES

Cohen H., Rogers, G.F.C, and Savanamutoo, H.I.H (1972), *Gas Turbine Theory*, 3rd Edition, Addison-Wesley Longman, London .

David O.I (2009) *"Nigeria Gas Master plan, overview and update"*. Available from http://www.businessdayonline.com/ ARCHIVE/index.php accessed on the 4th February 2011.

Wikipedia (2011*). Electricity Generation*, Retrieve from Wikipedia online Encyclopedia from the web site: http://www.wikipedia.org/wiki/Electricity Generation, accessed on the 25th August, 2011.

Wikipedia (2011*). Gas Turbine*, Retrieve from Wikipedia online Encyclopedia from the web site: http://www.wikipedia.org/wiki/gas turbine, accessed on the 6th May, 2011.

History and Overview of Natural Gas, a publication NaturalGas.Org Retrieve from the web site: http://naturalgas.org/overview/overview.asp accessed on the 6th May, 2011.

Nigerian gas reserve, the fact and stories, available from: http://www.nnpc-nigeria.com, accessed on the 5th Sept, 2011.

Energy generation and gas consumption data (2011) available from , Ughelli Power PLC,

Presidential Task Force on Power (2011). Retrieve from the web site: www.nigeriapowerreform.org/index.php/power-supply/generation on 6th Sept., 2011.