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Utilization of Nigerian precious Resource in the Niger Delta Region for the benefit of the Ecosystem

Okotie Sylvester[1], Ikporo Bibobra[2]
[1]Department of Petroleum Engineering, Federal University of Petroleum Resources, Effurun, Nigeria.
[2]Department of Chemical and Petroleum, Niger Delta University, Omasoma, Nigeria

ABSTRACT

This paper tried to provide a means of utilizing the gas flared from oil and gas field in the Niger Delta region of Nigeria domestically for the benefit of the nation. It also assess empirically the economic cost of gas flared in Nigeria from 1965 to 2008 to see the feasibility of utilizing our precious treasure 'Natural Gas' instead of wasting them. Data were obtained from Nigerian National Statistical Bulletin and analyzed using t test and correlation statistics in Microsoft excel data analysis toolpak. result revealed that gas flaring activities increased from 1965 – 1999 and was highest 1979. From 2000, the value has been falling and rising consistently over the years and that resulted in higher volume of gas utilized. It also showed a great disparity in the values between the volumes of gas produced and utilized which is an indication of gas wastage. Statistically, the volume of gas produced was almost equal the amount wasted and only in recent times that there was a turnaround value with gas utilized higher that the flared figure. This is an indication of improvement in the oil and gas sector, driving towards our nation's zero flared figures. The economic analysis shows that over the study years, Nigeria has wasted enormous amount of money as discovered from the test statistics that there is significant wastage of the nation's income as a result of gas flaring in Nigeria. Finally, a method was proposed to domestically utilize the excess gas from oil and gas production facilities for the benefit of the people living in the host country.

Keywords: *Gas production, utilization and flaring, economic wastage, health related diseases, Oil companies, gas processing facilities, Nigeria Government and domestic benefits*.

1. INTRODUCTION

The quest for gas exploration and production to meet global energy demands has been on the increase, with this drive, many exploration companies are beginning to find Natural gas in commercial quantities in many developing countries, both as dissolve gas found in oil during the search for oil reserve or in a large pool of free gas that has no oil associated with it as at the time Geologist met the reservoir. Hence, to increase our natural gas reserve, a more effort should be devoted on exploration for natural gas. The importance of this lies in the fact that natural gas has immerse potential to contribute to sustainable and diversified development in the countries where it is found. Therefore, for the proposed techniques in this study to be feasible, major accumulation of gas deposits as to be readily available. This may justify its export by pipeline or in the form of liquefied natural gas (LNG), and domestic purpose as fuel for power generation thereby generating attractive revenue, which can be used for development of the nation.

We should be aware at this point, that oil and gas exploration and production is a high risk and challenging venture. But despite this; new fields are still being discovered and the some of the old ones are yet to be developed to full capacity to produce the subsurface oil and gas volume that is recoverable at the surface tank. In Nigeria today, this has been on the increase with new oil and gas fields discoveries which has immensely benefitted us as a Nature but its excesses have been of negative effect to the host and nearby communities and as such, in other part of developed and developing countries having hydrocarbon in commercial quantities; have placed a more precise environmental restriction and fiscal penalties which as made the flaring of associated and non-associated natural gas a less attractive alternative for gas management. Thus, with this embargo, operating companies are frequently asked to device a means to contain their excess gas production. Moreover, the gas can be used as a secondary drive to enhance depleted oil reservoir, so they are forced to re-inject the excess gas for production of their crude oil reserves like the case of Mobil Oso Gas condensate plant which provide gas for reinjection into nearby oil reservoirs, methane as fuel to power their gas turbines and send the remaining propane plus to their natural gas liquid (NGL) plant at Bonny Island instead of flaring and as such wasting the natures resource.

Currently, the key driver in gas utilization plan is the growing demand of energy from the expanded economy with a challenge to improve technologies for the production, transportation and conversion of this resource. Thus, most economies of the world are diversifying away from oil to gas as energy source (Barnes *et al*., 2006). With this in mind, it is always difficult in a new oil field development project to incorporate a gas management or utilization scheme especially in offshore terrain which is capital intensive. Therefore, sending the produced gas to shore is usually not an economic option in new deep water oil developments in Nigeria because of the high cost of transporting low volumes of gas via pipeline infrastructure, and to accumulate the gas into a

gas management facility is a pretty constrained alternative due to the lack of gas management infrastructure in the area and as such, gases are still being flared today in various oil and gas field in Nigeria by these companies especially the Niger Delta Area. Therefore, this study presents a workflow that can be used to prevent the wastage of natural gas associated with oil production in Nigeria and aimed at the benefit that could be derived domestically if it can be processed and stored or distributed to different homes and sectors of the country. The fig. 1.1 shows a case of gas flaring.

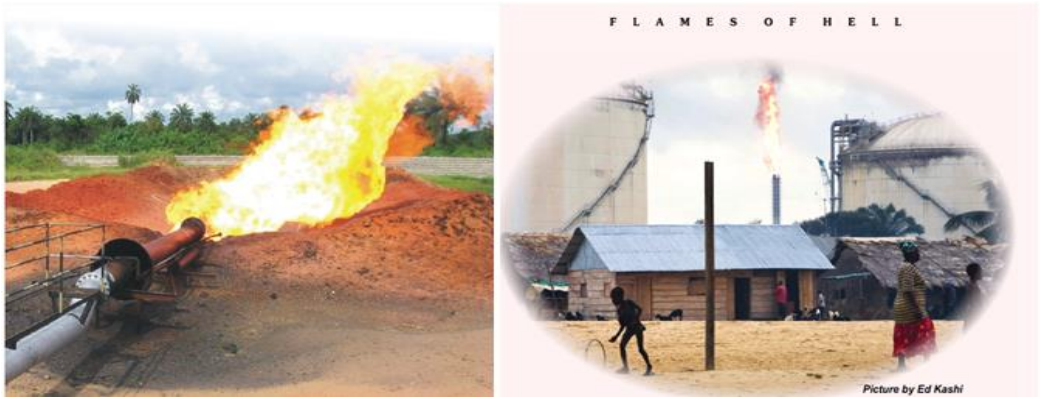

Figure 1.1: Gas flaring

From the above figure, you can imagine the kind of health related diseases the people living in these areas of operations are going through without adequate health care and fund to the individuals living in the affect communities. What a pity to this inevitable problem! However, these challenges in oil production which is having a negative impact on the people and environment though in some cases, positive impact could be unravel if we can find other means to dispose of the excess gas production and developing new ways of preventing the wastage of the associated gas produced is critical for the development of new deep water oil resources and also for the development of new non-associated gas reservoirs.

2. LITERATURES REVIEWED

Barnes, J. et al (2006) said in his work that the trend of natural gas around the world is growing in importance as an energy source, with many uses -residential, commercial, and industrial. Kojima, M. (2001) stated that there is even a possibility of producing vehicles that utilize natural gas as a fuel source which is currently being practice in Edo State of Nigeria. The option of how to transport this commodity is therefore a challenge and as such, gas pipelines are used to convey the natural gas reserves to a close markets. Where this is not feasible, an alternative technique has to be developed to transport the gas to the end users. This has led to the development of new ways of preventing the wastage of natural gas. Thus, monetize this relatively inexpensive 'stranded' gas.

Prior to this time, natural gas was regard as an unwanted product from crude oil production but has developed to be a more sorted for globally. Research as shown that about 20 percent of the primary energy requirements of the world are provided by natural gas. This development has been recorded in only a few years with the increased availability of the gas resources from different countries (Ikoku, 1992). The total global annual gas consumption is forecasted to rise to 2.9 trillion cubic meters by 2015 accounting for approximately 27% of the total primary energy supply (Patel, 2005).

Hill et al. (1985) in the research work carried out by the said names on how to economize and utilize associated gas stream using LNG, gas treatment, gas-liquids recovery (GTL), power generation, and residue gas compression. This work proposed by this author showed that, the distribution of the commodity to local customers will have a create impact on the host countries especially the developing ones. They also noted that though the practice of flaring "associated gas" has historically being an accepted activity in both offshore and onshore crude oil production. Although recognized as a potentially significant source of energy and revenue, factors such as marginal rates, rote production locations, soaring field development costs, and severe space limitations have caused offshore "associated gas" too often be considered as economically impossible to utilize.

Stella Madueme (2010) did a work on Gas Flaring activities of major oil companies in Nigeria. Her empirical investigation was focused on finding out the amount of gas flared by several major oil companies in Nigeria. It also tried to show the general trends in gas flaring in seven major oil companies operating in Niger Delta area. Hence, the recommended that there should be increased government taxation per cubic meter of gas flared in order to reduce its environmental negative implications. The government should set and enforce target policies that limit gas flaring to very small percentages between now and the next ten years. For example the government can enforce ten percent flaring by the next five years and ensure that this percentage moves down considerably by the next ten years. Gas flared should be captured by these companies and greater local consumption should been encouraged through reduction in local gas prices. Increased private sector involvement in gas investment, blending of gas with other fuels to obtain more useable products should be done to reduce the economic

wastages through flaring. Oil companies can be further motivated to reduce flaring activities by the government introducing national awards or tax holidays for companies with best records in reduction of gas flaring activities.

Onwukwe (2009) worked on gas to liquid technology in Nigeria. His article examined the prospect of Gas-to-Liquid (GTL) conversion technology as a sustainable natural gas utilization option. He noted that this technology will make possible the chemical conversion of natural gas into clean diesel, naphtha, and kerosene and light oils, as marketable liquid products. According to him this conversion will contribute to the elimination of flared gas and reduces the country's overdependence on imported refined petroleum products.

Iwayemi and Adenikinju, (2001) identify the theoretical condition linking resource rents to economic sustainability. However, despite the various ways in which natural gas can be used in Nigeria, approximately 75% (by 1998), 63% (by 2000) and 24.30% (by 2010) of the total gas output were flared. For instance, if you take gas which is flared in Africa which is around 40 billion cubic meters each year, with Nigeria contributing 46% and if you used that to generate power in efficient modern power plants, you could actually double the power production in sub-Saharan African, excluding South Africa (Kareem *et al*., 2012).

3. WHAT ARE THE QUESTIONS TO ADDRESS BEFORE GAS MANAGEMENT STRATEGY?

There are vital factors which are keys to the operating companies based on optimum gas strategy and policy developed by the host country. Firstly, they will ask themselves serious of questions before moving down to the host country to sign the memorandum of understanding that will bind its operations. These are:

- What are the types of natural gas reserves already discovered and the likely hold of prospective domestic gas resource and also, are these reserves economical viable i.e. an abundant resource base?
- The stage in which the host country has developed the local natural gas industry?
- What markets are available for the processed gas both locally and globally? i.e the growing demand of energy from expanded economy.
- Are there existing gas facilities, if any, what are the technologies employed?
- How do we gather the gases and where are the gas fields located?
- How the local gas industry can be organized and what is the impact of the global outlook for gas and the environment?
- How will the entire gas facilities be managed effectively to yield expected returns on investment?

4. STATEMENT OF PROBLEM

With an increasing demand of power generation means, transportation fuels, automobiles, global environmental needs, international market growth, and other factors which could initiate new and better technologies of gas utilization, here we can see the slowdown in oil and gas exploration activity, and delays in project development, including LNG projects which could be as a result of the uncertainties in Nigeria's investment policies and regulatory framework. However, the long-awaited and delayed Petroleum Industry Bill (PIB) could potentially unravel these investment uncertainties and set a regulatory support for the country's oil and gas industry but the question is how soon this will be in place?. In recent years, nations across the globe have engaged in substantial regulatory efforts to curb flaring (wastage of natural gas) which have considerably affect the inhabitant of the oil and gas operation areas. Unfortunately, regulation alone has not yet defeated the problem. To the reasonable mind, identifying methods for economic production of flared reserves is possibly the best option to put an end to flaring. In a scenario where wasted resource “being natural gas” is measure in monetary equivalent, an immediate attention is needed to stop the wastage. It is a legitimate hope that the project technologies analyzed here can offer such an economic means to monetized the flared gas, hence, a particular challenge here is to ensure that these new developments benefit the nation in question in all ramification.

5. OBJECTIVES OF STUDY

The objective of the present study is to assess the economical lost in the volume of gas that has been flared over the period used in this study and make some recommendations on technical and commercial feasibility of different gas management options for the disposal and potential monetization of associated gas from various oil and gas fields in Nigeria.

The study aims to:

- Carry out an empirical study on the trend of Nigeria’s total quantity of gas produced per year and the amount utilize via any of the natural gas utilization technology in the country and compare with the quantity flared to the environment. Also, evaluate the economic value of the gas flared.
- Suggest solutions to the issue of gas flaring by adhering to the monetization techniques presented in this study
- Address domestic gas supply availability in a manner that precisely balances the need for domestic economic growth and revenue generation from exports; and
- Propose an implementation approach to discourage companies from gas flaring and more importantly; with Nigerian Government full commitment to encourage these companies to fully participate in providing excess gas from their oil and gas surface facilities and then supply to the country’s gas utilization facilities in a

manner that ensures sustained gas supply to the domestic market.

6. METHODOLOGY OF STUDY

Microsoft excel data analysis toolpak was adopted in this study to perform the statistical analysis. Data were obtained from Nigerian National Statistical Bulletin as shown in appendix A and was analyzed using percentages, t test and correlation statistics. Also, an economic analysis was performed on the volume of gas flared to see the feasibility of utilizing our precious treasure 'Natural Gas' instead of wasting them. Sources of information were literatures, libraries, SPE Journal, technical papers on GTL and LNG technology and from major oil industries

6.1 Decision Rule

If $t_{calculated} > t_{table}$: we reject the null hypothesis H_o
If $t_{calculated} < t_{table}$: we accept the alternative hypothesis H_1

6.2 The sets of hypothesis used in this study are as follows:

- Now, if we are to justify that about 98% of the gas produced in Nigeria are been utilized via different technology employed in all the oil and gas companies operating in the country. Thus, we put forth a hypothesis as:

H_o: There is no significant difference between the gas produced and gas utilized in Nigeria and if there is any, it merely due to chance
H_1: There is significant difference between the gas produced and gas utilized

- If we are to test the extent in volume to which our gas has been wasted, we put forth a hypothesis as:

H_o: There is no significant difference between the gas produced and gas flared in Nigeria and if there is any, it merely due to chance
H_1: The claim is not legitimated

- If we say 50-50 of gas utilized and flared then;

H_o: There is no significant difference between the gas flared and gas utilized in Nigeria and if there is any, it merely due to chance
H_1: There is significant difference between the gas flared and gas utilized

- Finally, to carrying out economic analysis on the volume of gas wasted, then

H_o: There is significant wasted of the nation's income as a result of gas flaring in Nigeria
H_1: The claim is not legitimated

7. RESULTS AND DISCUSSIONS

The results of the statistical analyses help us to understand the outcome of the claims of this study, for example, whether or not some variables have an effect, related, whether differences among groups of observations are the same or different, etc. Hence, the statistical analysis was used to substantiate the findings of this study and help us to say objectively when we have significant results. Also, calculated results are shown in appendix section.

Following the result of the t-test on the stated hypothesis for gas flared and gas produced. We observed that the value calculated is a little lower than the critical values at 1% and 5% level of significance for two-tail test. Hence, we accept the null hypothesis (H_0) and reject the alternative hypothesis (H_1) at 1% and 5%. These implies that there is no significant difference in the volume of gas produced and that flared in Nigeria for period of this study which is an indication that Nigeria has wasted a lot gas almost equal the amount of the volume produced. Therefore, there is a need for a proper utilization schemes to handle this volumes.

For the case of gas produced and utilized, and also for gas flared and utilized, we reject the null hypothesis (H_0) and accept the alternative hypothesis (H_1) at 10% and 5%. which implies that there are great disparities between gas produced and utilized. This result also agrees with the result obtained for the test between the volume of gas produced and flared. Thus, since there is significant difference between the gas produced and that utilized, means greater volume of the gas are being flared. Only in recent times that there was a turnaround value with gas utilized higher that the flared figure. This is an indication of improvement in the oil and gas sector, driving towards our nation's zero flared figures.

Fig. 2, indicates that Nigeria has been wasting substantial amount of gas in the form of flaring (which would have comminuted to cash) into our environment, affecting lives and properties of the people residing in the operating areas. At this point, one could imagine what the country would have achieved if this commodity was actually converted to monetary terms to take care of various needs of the natives of the operation areas who are still living in abject poverty with deteriorating health conditions. Hence, these lead to the aim of the study 'developing means of preventing the wastage of our gas produce in the country'.

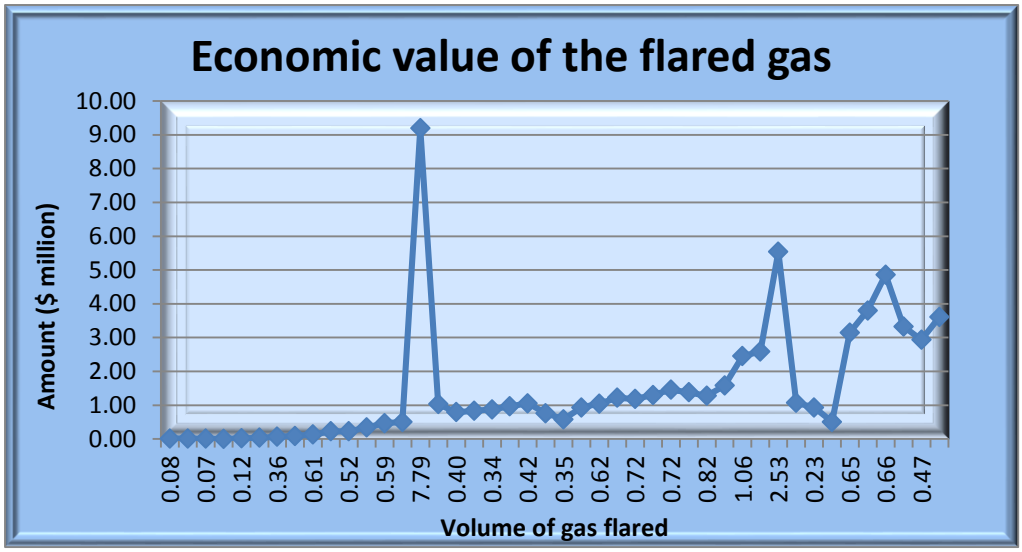

Figure 2: Analysis of the economic value of gas flared

8. PROPOSED IMPLEMENTATION APPROACH TO UTILIZE FLARED GAS

To provide an implementation approach to discourage companies from gas flaring and with Nigerian Government full commitment to encourage these companies to fully participate in providing their excess gas from their oil and gas surface facilities and supply to the country's gas utilization facilities in a manner that ensures sustained gas supply to the domestic market. Here is a tentative approach suggested in this study.

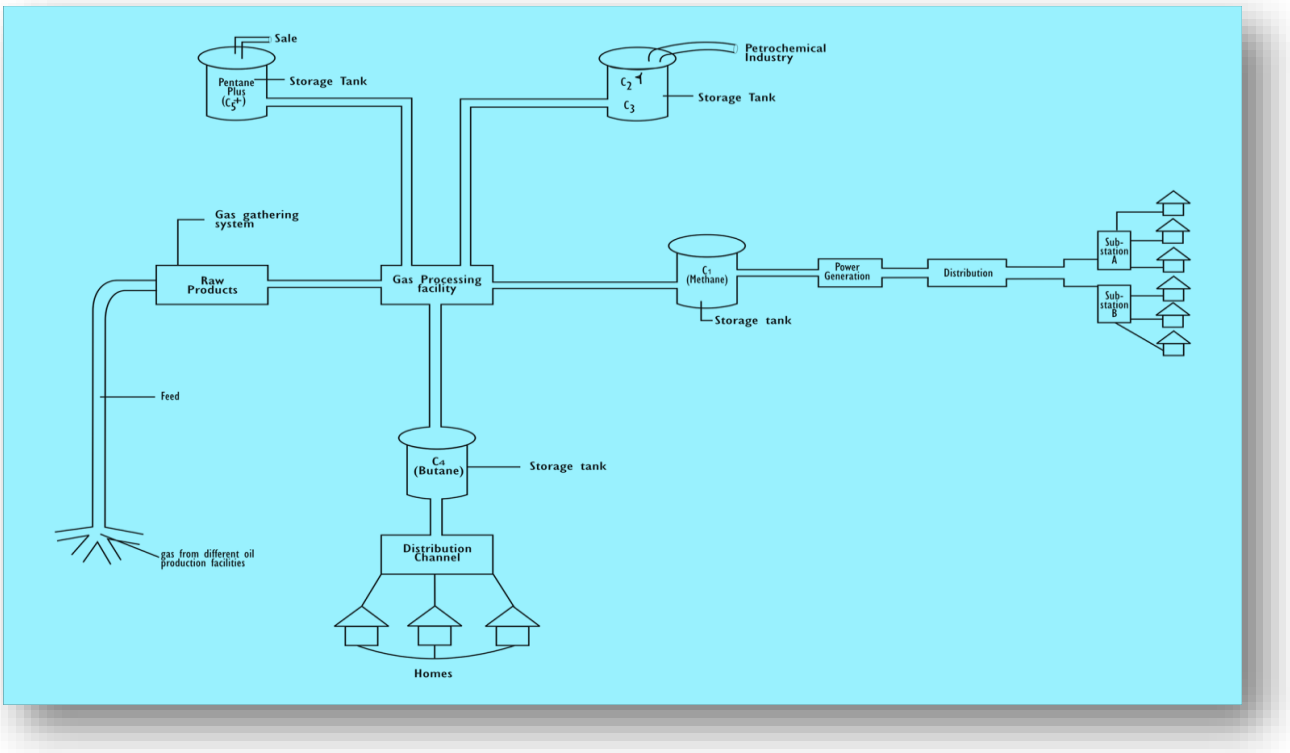

Figure 3: Proposed gas utilization means in the country to discourage gas flaring

9. DISCUSSION OF THE PROPOSED GAS UTILIZATION METHOD

Quoted by the minister of Power, Professor Chinedu Nebo (2013); that Nigeria as an emerging economy is set to provide the best market for investors especially in the power sector. Also, there is no doubt that financial experts are in agreement that the current reform in the power sector, especially with the privatization of electricity generation and distribution will dramatically lower costs of goods and improve productivity in Nigeria's economy which implies that, there is an urgent need of gas utilization scheme in the country for power generation and distribution.

We can see from the data analysis that Nigeria as a country has wasted a lot of money due to gas flaring which has an effect on the economic growth of the country. Proposed in this study is a tentative approach the Government could use to stop gas flaring to an extent if they adhere strictly to it and as result of it, everybody living in the country will benefit in one way or the other because this gas could reach them in their various homes in the form of electricity or cooking gas.

The diagram shown above represents the processes developed to utilize associated and non-associated gas from oil production facilities within the country. The inlet is the gas gathering system where gas is collect from different fields in the country to send to a gas processing facility either developed already or yet to be built. The gas is separated into different components as seen in the fig. 3 above. The methane can be sent to gas turbine built in strategic places across all the states in Nigeria to generate electricity which will then be distributed to all homes. Also, It can be compressed at high pressure and store as compressed natural gas which can be used in place of gasoline (petrol), Diesel fuel and propane/LPG combustion engine automobiles that have been modified, this is currently going on in Edo State were cars are converted to a dual fuel system especially the commercial drivers or in vehicles which were manufactured for CNG use, either alone or with a segregated gasoline system to extend range (dual fuel). It combustion produces fewer undesirable gases than the fuels mentioned above. It is safer than other fuels in the event of a spill, because natural gas is lighter than air and disperses quickly when released. It does not contain any lead, it powered vehicles have lower maintenance costs than other hydrocarbon-fuel-powered vehicles and it has less pollution and more efficiency. Thus, with these concepts, the inhabitant benefit immensely.

The ethane and propane can be sent as raw materials to a petrochemical plant like the one we have at Eleme in Rivers State.

Furthermore, there will not be stress in going out to fill our gas cylinders if the butane product is channel to our homes as cooking gas and also to heat up homes during winter period. Finally, the pentane plus can be sent via pipeline for sales or stored in a tank for future use. We should also note that these products can be piped for sale. There is this popular saying that "it is easier said than done" and if Government could adhere to the method proposed in this study, there will be a lot of revenue generation in the part of the government, stabilize environment for people to live in without facing related health diseases emanating from the gas flaring and even peace to the ecosystem.

10. RELEVANCE OF STUDY

The effect of gas flaring in Nigeria has affected the lives of people living close to the oil and gas operational areas, leaving them with various kinds of disease, affected farm lands, killing of aquatic lives and bad drinking water just to mention a few. These have been on the increase as more oil fields are developed. Besides, Nigeria has wasted a lot of money as a result of the volume of gas flared daily, which implies that if the government and the oil industry can completely involve in the techniques for natural gas monetization shown in this work, there will be social-economic stability, peoples health will be improved, development in the country as a result of cash from gas sold, industries will have steady supply of electricity generated from this wasted gas. Thus a huge benefit awaits us as a nation if implemented.

11. CONCLUSIONS

Based on the data analysis, result revealed that gas flaring activities increased from 1965 – 1999 and was highest 1979. From 2000, the value has been falling and rising consistently over the years and that resulted in higher volume of gas utilized. It was discovered also that claim on gas produced and flared implies that there is no significant difference in the volume of gas produced and that flared in Nigeria for period of this study which is an indication that Nigeria has wasted a lot gas almost equal the amount of the volume produced. Considering the claim for gas produced and utilized, we reject the null hypothesis and accept the alternative hypothesis which indicates a great disparity in the values. The result for gas flared and utilized did not agree with the afore-stated hypothesis which means that the volume of gas flared in Nigeria is far greater than the volume utilized; only in recent times that there was a turnaround value with gas utilized higher that the flared figure. This is an indication of improvement in the oil and gas sector, driving towards our nation's zero flared figures. Finally, the economic analysis shows that over the study years, Nigeria has wasted enormous amount of money as discovered from the test statistics that there is significant wasted of the nation's income as a result of gas flaring in Nigeria.

12. RECOMMENDATIONS

This review of the wastage of Nigeria associated natural gas in the form of gas flaring as confirmed the need for various gas utilization technologies to be in place. Based on the data analysis to justify all the claims/hypothesis stated above, the following recommendations are made:

- For every oil field developed in the country, there should be a gas handling facility built alongside the oil field development to take care of the gas associated with oil production or they can tie the gas to a nearby compressed gas station. Also, an embargo on tax payable per cubic feet of gas flared should be raised. This amount should be more than the prevailing price of the gas to encourage companies to build gas handling facilities and discourage them of flaring gas.
- The Nigerian government should provide incentives to the operating company with less activities of gas flaring for a stated period of time to encourage others to follow same.
- The Nigerian government should embrace and harness the economic opportunities that natural gas monetization would offer the nation.
- The Nigerian government should develop various domestic means of utilizing the produce gas. Such as powering our homes with cooking and heating gas, electricity by building sub gas compressed station in various parts of the country and gas turbines to utilize the gas for power generation as shown in figure 3.
- A wide spread of CNG sections and conversion centers in all states of Nigeria to reduce pollution and low maintenance cost of vehicle usage.
- Government should continue to promote private investment and ownership in major gas processing and distribution facilities.

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Appendix A

Table A1: Economic Analysis on the quantity of gas flared over the study period

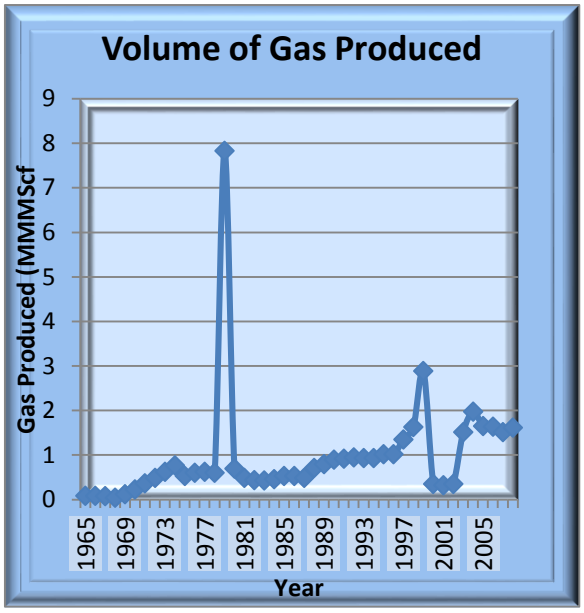
Year	U.S. Natural Gas Wellhead Price (Dollars per Thousand Cubic Feet)	Quantity of gas flared (Trillion cubic feet)	Economic value of flared gas ($ million)
1965	0.16	0.07739	0.012382
1966	0.16	0.07623	0.012197
1967	0.16	0.0717	0.011472
1968	0.16	0.03712	0.005939
1969	0.17	0.11502	0.019553
1970	0.17	0.22532	0.038304
1971	0.18	0.35708	0.064274
1972	0.19	0.47708	0.090645
1973	0.22	0.60844	0.133857
1974	0.3	0.75821	0.227463
1975	0.44	0.51913	0.228417
1976	0.58	0.58381	0.33861
1977	0.79	0.59329	0.468699
1978	0.91	0.55048	0.500937
1979	1.18	7.7892	9.191256
1980	1.59	0.64857	1.031226
1981	1.98	0.40102	0.79402
1982	2.46	0.3381	0.831726
1983	2.59	0.33805	0.87555
1984	2.66	0.36294	0.96542
1985	2.51	0.42039	1.055179
1986	1.94	0.39409	0.764535
1987	1.67	0.34804	0.581227
1988	1.69	0.55323	0.934959
1989	1.69	0.61844	1.045164
1990	1.71	0.71486	1.222411
1991	1.64	0.72106	1.182538
1992	1.74	0.7472	1.300128
1993	2.04	0.7152	1.459008
1994	1.85	0.74765	1.383153
1995	1.55	0.82476	1.278378
1996	2.17	0.72791	1.579565
1997	2.32	1.05707	2.452402
1998	1.96	1.32078	2.588729
1999	2.19	2.52901	5.538532
2000	3.68	0.29036	1.068525
2001	4	0.23356	0.93424
2002	2.95	0.17106	0.504627
2003	4.88	0.64551	3.150089
2004	5.46	0.69637	3.80218
2005	7.33	0.66344	4.863015
2006	6.39	0.52044	3.325612
2007	6.25	0.46972	2.93575
2008	7.97	0.45242	3.605787

Source: U.S Energy Information Administration
Available on the web page: http://tonto.eia.gov/dnav/ng/hist/n9190us3a.htm

Table A2: Volume of gas produced, utilized and flared in Nigeria from 1965-2008

Time (Year)	Gas Produced (MMMscf)	Gas Flared (MMMscf)	Gas Utilized (MMMscf)	% of Gas flared of total gas produced (%)	% of Gas utilized of total gas produced (%)
1965	0.0807	0.0774	0.0033	95.93	4.07
1966	0.0823	0.0762	0.0061	92.57	7.43
1967	0.0746	0.0717	0.0029	96.13	3.87
1968	0.0414	0.0371	0.0043	89.67	10.33
1969	0.1168	0.1150	0.0018	98.45	1.55
1970	0.2274	0.2253	0.0020	99.10	0.90
1971	0.3623	0.3571	0.0052	98.55	1.45
1972	0.4848	0.4771	0.0078	98.40	1.60
1973	0.6196	0.6084	0.0112	98.19	1.81
1974	0.7694	0.7582	0.0112	98.55	1.45
1975	0.5283	0.5191	0.0091	98.27	1.73
1976	0.6025	0.5838	0.0187	96.90	3.10
1977	0.6208	0.5933	0.0275	95.57	4.43
1978	0.6033	0.5505	0.0528	91.24	8.76
1979	7.8330	7.7892	0.0438	99.44	0.56
1980	0.6952	0.6486	0.0466	93.29	6.71
1981	0.4846	0.4010	0.0836	82.76	17.24
1982	0.4356	0.3381	0.0975	77.62	22.38
1983	0.4299	0.3380	0.0919	78.63	21.37
1984	0.4603	0.3629	0.0974	78.85	21.15
1985	0.5258	0.4204	0.1054	79.95	20.05
1986	0.5306	0.3941	0.1365	74.27	25.73
1987	0.4838	0.3480	0.1358	71.94	28.06
1988	0.7094	0.5532	0.1562	77.98	22.02
1989	0.7975	0.6184	0.1790	77.55	22.45
1990	0.8945	0.7149	0.1796	79.92	20.08
1991	0.9193	0.7211	0.1982	78.44	21.56
1992	0.9471	0.7472	0.1999	78.90	21.10
1993	0.9286	0.7152	0.2134	77.02	22.98
1994	0.9339	0.7476	0.1862	80.06	19.94
1995	1.0204	0.8248	0.1957	80.82	19.18
1996	1.0153	0.7279	0.2874	71.69	28.31
1997	1.3461	1.0571	0.2890	78.53	21.47
1998	1.6291	1.3208	0.3083	81.08	18.92
1999	2.8876	2.5290	0.3586	87.58	12.42
2000	0.3525	0.2904	0.0621	82.37	17.63
2001	0.3175	0.2336	0.0839	73.57	26.43
2002	0.3467	0.1711	0.1756	49.34	50.66
2003	1.5115	0.6455	0.8660	42.71	57.29
2004	1.9750	0.6964	1.2787	35.26	64.74
2005	1.6494	0.6634	0.9859	40.22	59.78
2006	1.6354	0.5204	1.1150	31.82	68.18
2007	1.5152	0.4697	1.0455	31.00	69.00
2008	1.6158	0.4524	1.1634	28.00	72.00

Source: Nigerian National Statistical Bulletin 2005 to 2008; MMMscf means trillion standard cubic feet.



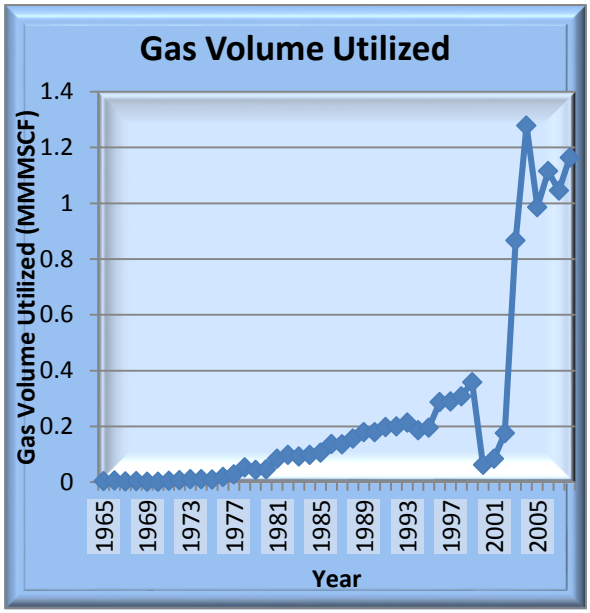
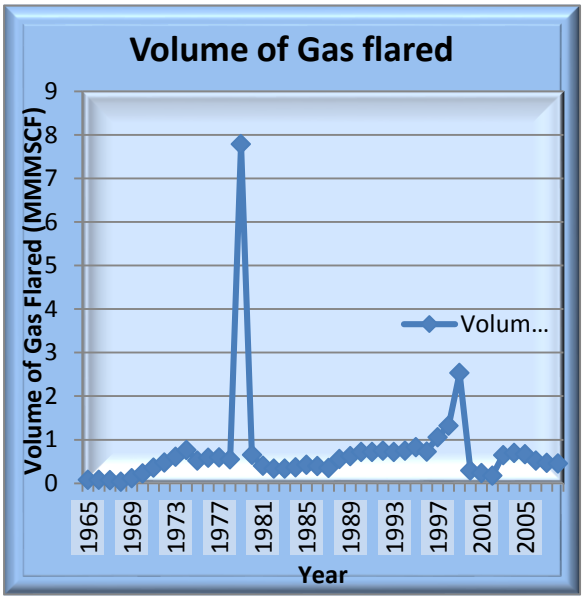


Figure A1: Trend of Gas Produced **Figure A2: Trend of Gas Utilized**



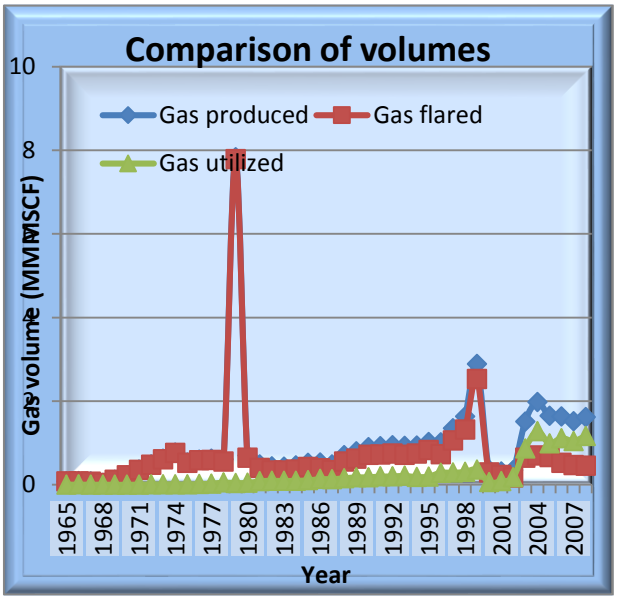


Figure A3: Comparison of the Trend of Gas Produced, Utilized and Flared

Table A3: t-test for gas flared and produced

t-Test: Two-Sample Assuming Unequal Variances		
	Variable 1	***Variable 2***
Mean	0.716153	0.95547219
Variance	1.3527925	1.47040851
Observations	44	44
Hypothesized Mean Difference	0	
df	86	
t Stat	-0.944785	
P(T<=t) one-tail	0.1737078	
t Critical one-tail	1.6627654	
P(T<=t) two-tail	0.3474155	
t Critical two-tail	1.9879342	

t-test A4: for gas utilized and gas produced

t-Test: Two-Sample Assuming Unequal Variances		
	Variable 1	***Variable 2***
Mean	0.239319	0.955472
Variance	0.124087	1.470409
Observations	44	44
Hypothesized Mean Difference	0	
df	50	
t Stat	-3.76201	
P(T<=t) one-tail	0.000222	
t Critical one-tail	1.675905	
P(T<=t) two-tail	0.000443	
t Critical two-tail	2.008559	

Table A5: t-test for gas utilized and gas flared

t-Test: Two-Sample Assuming Unequal Variances		
	Variable 1	***Variable 2***
Mean	0.239319186	0.716153
Variance	0.124087313	1.352792
Observations	44	44
Hypothesized Mean Difference	0	
df	51	
t Stat	-2.602680213	
P(T<=t) one-tail	0.00604056	
t Critical one-tail	1.675284951	
P(T<=t) two-tail	0.012081121	
t Critical two-tail	2.007583728	