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Gas Flaring, Transportation and Sustainable Energy Development in the Niger-Delta, Nigeria

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ABSTRACT Nigeria is ranked within the top 10 countries of the world with the largest proven deposits of natural gas; however, it flares much more than the combined energy needs of sub-Saharan Africa in a day. This phenomenon has brought socio-economic losses and health related problems to the Niger- Delta and its people. Estimates from the World Bank suggest that amounts in excess of 100billion cubic meters of natural gas are burnt yearly. The flaring of this gas is deemed to be a colossal waste of resources, particularly in a country experiencing huge energy shortages. This article thus makes a review of the attendant effects of continued gas flaring from an economic stand point; assesses the country's commitment to end the practice of gas flaring and lastly explores market opportunities (local and international) for the various liquefied natural gas (LNG) projects. This paper, will contribute towards resolving the above stated problem, especially the provision of energy to a rapidly growing population in a sustainable manner. This would be in the form of the development of natural gas as a viable form of energy locally, as well as the movement towards the opening up of new international markets for liquefied natural gas.

1. INTRODUCTION

The United States government suggests that Nigeria is Africa's biggest producer of crude oil (ranking 11th in the world), and that the country's oil reserves are substantial with gas reserves estimated to be even greater (Osuoka and Roderick 2005).

From an economic perspective, the flaring of this associated gas is a colossal waste to the communities where exploitation continues and to the entire country which remains in the grip of a very severe energy crisis. From a political stand point, oil exploitation has become an important political tool for the mobilization of agents of the state against those who hold differing positions on the practices surrounding oil exploration activities in the Niger Delta (Watts 2001, cited in Ishisone 2010). With regards to the social perspective, the exploration for oil in the Niger-Delta area, shown in Figure 1, has brought about an unquantifiable level of marginalization to the people of the area; and this has in turn led to the high levels of restiveness currently being experienced in the region.

1.1 Literature Review

1.1.1 Gas Flaring in Nigeria

The exploration for oil over the years continues to pose several environmental challenges as a result of certain practices within the industry. Over time, extensive exploration for oil has had a huge negative impact on human health, the local culture and the self aspirations of the people of this region (Ishisone 2010). One such practice associated with the exploration for crude oil is the flaring of gas into the atmosphere (see Fig.2).

Gas flaring as a process, involves the use of an elevated vertical stack or chimney as a channel through which undesired gas or combustible gas and liquids are burnt as they exit the flare stacks on oil wells or oil rigs (Wikipedia 2009). The origins of gas flaring can be traced to the activities of Shell- BP with the epoch- making discovery of crude oil in commercial quantity at Oloibiri (Bayelsa State) in August 1906 (Jimoh and Aghalino 2000). As Osuoka and Roderick (2005) assert, "the first field was found in 1956 and the first export was made in 1958. Flaring of gas mixed up with crude oil began right at the start, and so did a recognition of its unacceptability" (p.6).

1.1.2 Global Gas Flaring Trends

Estimates from the World Bank suggest that amounts in excess of 100billion cubic meters of natural gas are burnt yearly. This figure is stated to add up to approximately 30.6 billion dollars which is double the total consumption for Africa. The report goes on to assert that the greatest flaring operations occur in the Nigerian

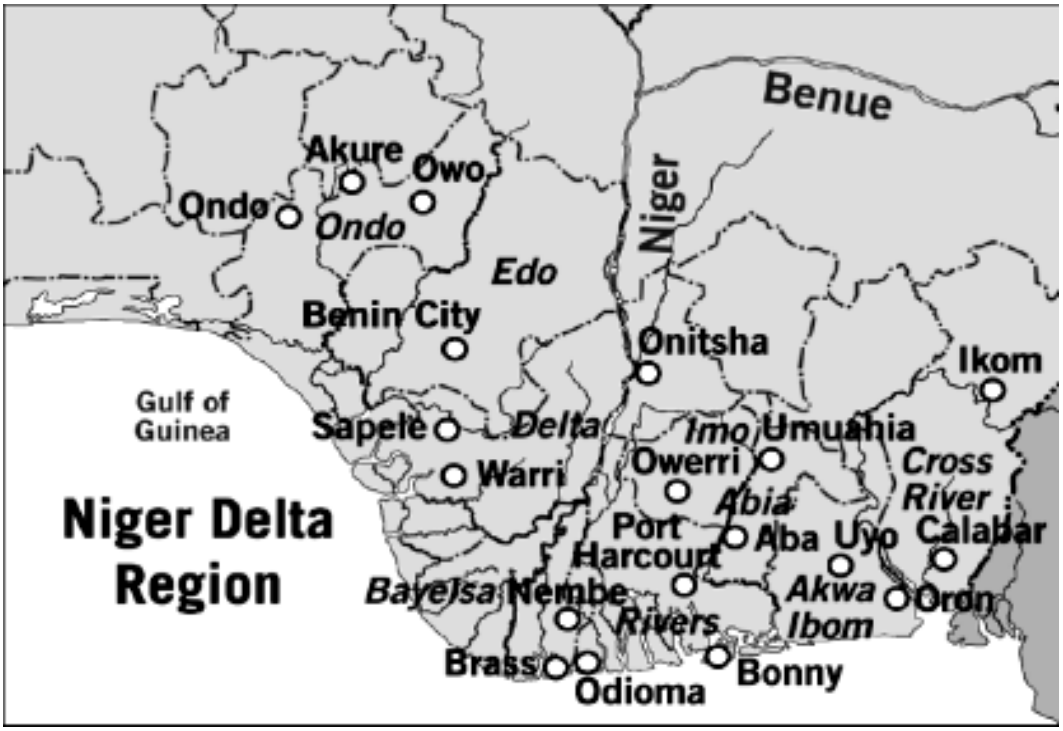

Fig. 1. Map of the Niger- Delta, Nigeria
Source: Malumfashi G I 2008

Fig. 2. Gas flare of Obama, Bayelsa State of Nigeria
Source: Ishisone M 2010

Niger-Delta (Wikipedia 2009). According to The Economist (2009), the southern region of Nigeria alone accounts for the burning of 2 million cubic feet of natural gas daily which is more than that flared anywhere else globally. In a media briefing in October, 2004, 'Friends of the Earth' (an environmental organization) stated that there is confusion as to how much oil and natural gas Nigeria exploits yearly. The report goes on to assert that "3.5 billion standard cubic feet (scf) of associated gas was produced in 2000, of which more than 70 per cent was burnt off, i.e. flared. As oil production has increased, Nigeria has become the world's biggest flarer, both proportionally and absolutely, with around 2 billion scf, perhaps 2.5 billion scf a day being flared" (p.1). The report also singled out the Shell Petroleum Development Company of Nigeria Ltd (SPDC) as the biggest culprit.

1.1.3 Gas Flaring in Nigeria

The continued act of gas flaring in the Niger-Delta, which has reached world record levels, is directly linked to the activities of the multinational companies namely: Shell, Exxon Mobil, Chevron Texaco, Agip and Total FinaElf in concert with the Nigerian National Petroleum Corporation (the state owned oil company). It is astonishing that despite the act of gas flaring in Nigeria being declared illegal in 1984, this as a result of the Associated Gas Reinjection Act of 1979, gas flaring continues unabated. The reasons for this are rather complex and seem intractable for a number of reasons.

At the onset of oil exploration in Nigeria, natural gas was deemed to be a waste product that resulted from the process of removing crude oil from the ground. This perception was indeed the dominant thought in the industry at the time. Thus, the practice became institutionalized and operational throughout the industry, and although there have been measures to try and capture the flared gas through the setting up of the Bonny LNG project in 1989 together with other gas gathering projects, these measures have been largely unsucccessful. The measures have been fraught with operational and bureaucratic challenges with the attendant losses to the economy (Adebayo 2010). The continued flaring of gas, which constitutes 75% of gas produced, also means more damage is being wrought on the local ecology and on the environment as a whole. This in addition to the continued waste of a resource that is finite in nature and for which experts have warned may be totally depleted by the year 2020.

As a result of this perception that associated gas was deemed to be a by-product, no facilities were put in place to capture and store the gas. This was indeed evident at the dawn of exploration in Nigeria when British officials cited economics and a lack of markets for the continued flaring of gas. Thus, it was cheaper then to flare the gas as against storage. It was felt that the laying of pipelines and the creation of storage tanks was too expensive an undertaking at the time; and coupled with this was the perceived lack of a viable market for the gas. This was, to say the least, double standards on the part of the British in that they took a contrary position in relation to oil exploration and the attendant associated gas flaring in the North Sea, as the practice was totally discouraged from the onset. Thus Nigeria, it seems, was bequeath with an oil industry that institutionalized the flaring of gas, with the total disregard for the attendant impact on the environment and the huge waste of an energy resource (Osuoka and Roderick 2005). It, thus, becomes inevitable that challenges would exist while trying to re-organize the petroleum sector. These challenges come in the form of expanding the network of pipelines and increasing the number of gas storage tanks. This coupled with the need to find markets for the gas within and outside the country has resulted in bureaucratic bottlenecks in the form of delays in executing market oriented projects like the West African Gas Pipeline project and the continued somersaults on the part of past and present Nigerian governments as to when to enforce the gas flare-out date on the multinational oil companies. This inaction, on the part of the government and the multinational oil companies can be traced to the fact that the Nigerian oil industry is steeped in corruption; which has been to the benefit of the ruling local elite. As a result, policies of best practice that should underpin the activities within the industry are non-existent, thus accountability and transparency are words rarely used in the industry and this has had a lasting impact on the continued flaring of gas or indeed any other negative practice within the industry.

1.1.4 Transport Environment in the Delta

In developing countries, Nigeria inclusive, the over-reliance on road transportation as the sole means of transporting people and goods continues to be a significant contributory factor to the phenomenon of climate change with its attendant negative effects. In Nigeria today, and in the Delta region in particular, there is urgent need for the government and stake holders in the transportation sector to fashion out an eco-friendly transportation policy and system that enhances the efficiency of the movement of people and goods; and also reduces the amount of CO_2 emissions that continue to be released into the atmosphere. This release of carbon dioxide , particularly from vehicular traffic, in the delta region ranks second to gas flaring as the main contributory factor to the environmental degradation currently being experienced in this region. The need for a systemic integration of the various transport modes within the country can never be overemphasized. The use of pipelines to transport raw crude and refined petroleum products must be revitalized.

There is also a need for policy makers to integrate the concept of green energy sources into the transportation sector. The use of these alternative sources of fuel within the transport system would dramatically cut the very high CO_2 emissions, and invariably the large carbon debt that continues to grow. New technologies that encourage the use of fuel efficient engines should also be adopted while vehicles with older engines that produce significantly higher emissions into the atmosphere should be phased out or out rightly banned from the roads. Nigeria being a signatory to international agreements on the sustenance of the environment, i.e. the Kyoto protocol must now implement, without delay, all facets of such agreements in order to enhance the concerted efforts now put in place to tackle climate change and its attendant effects.

2. METHODOLOGY

Data used in this article have been obtained from secondary sources; the analysis of which has been descriptive. Percentages and rankings have been used, and they have been presented in the form of tables and graphs.

3. OBSERVATIONS AND DISCUSSION

The flaring of gas is deemed to be a waste of a precious resource. The analysis of the data presented in this article reveals that the practice of gas flaring in the Niger-Delta of Nigeria remains and continues unabated. Nigeria has remained within the top two in terms of countries that flare the most gas during the process of oil explorations and this is clearly evident from statistics available in Table 1 and Figure 3. As can be rightly observed, the average Nigerian cannot afford cooking gas and most industries in the country continue to lack the required energy to operate at full capacity (Alakpodia 2000). With this obvious shortage, the great waste persists unabated and with little or no regard for the environmental impact on the host communities, the local ecology and the global environment. The environmental cost of gas flaring is indeed very high; the effects with regards to vegetation, human health and the micro-climate are hair–raising. The ubiquitous nature of the flares coupled with the unfettered burning of the gas within the Niger-Delta continues to push communities in the area to the margins of existence. This continued flaring of gas has resulted in the massive degradation of the delta with the attendant destruction of the natural ecosystem and way of life for the people of the area, who are mainly involved in primary economic activities like fishing and farming. Table 2 shows the effect gas flaring has had on agricultural output in the region and it is clear from the statistics that the damage is indeed significant on agricultural production in the area. Aghalino (2000) notes that " apart from the deafening howl of the raging fires at gas flare sites, the thick smoke which bellows in to the sky falls back as acid rain which has poisoned most of the rivers and lakes in the Niger-Delta" (p.143). Acid rain, with the constant occurrence of oil spillage has devastated once thriving communities in this area (Ikporukpo 1983; Aghalino 1998). The flaring of gas also results in the release of harmful toxins which, according to the 'Friends of the Earth' report of October, 2004, includes benzene an air pollutant which invariably gets back into the soil and vegetation of the area as a result of the water cycle thus leading to a deterioration in soil quality. This coupled with the intense heat generated from these flares

(thermal pollution) has resulted in the defoliation of the once luxuriant mangrove and rainforests. Alakpodia (2000) has shown that "the eluviations process and hydrolysis which could enhance the formation of insoluble clay minerals in soils are disturbed by the heat from the gas flame which has been on for about 38 years" (p.7). Similarly, the ecosystems of these areas have become damaged and would require a long period to recover from the impact of this environmental degradation (Ikelegbe 1993 in, Aghalino 2000).

Table 1: Top 20 flaring countries.

2004 Rank	*Country*	*Reported flaring 2004**	*2004 Rank*	*Country*	*Reported flaring 2004**
1	Nigeria	24.1	10	Indonesia	3.5**
2	Russia (total)	14.7	11	USA	2.8
	Khanty Mansiysk (KM)	6.4	12	Kazakhs-tan	2.7
	Russia (exclu-ding KM)	8.3	13	Libya	2.5
3	Iran	13.3	14	Azerbaijan	2.5
4	Iraq	8.6	15	Mexico	1.6
5	Angola	6.8	16	UK	1.6
6	Qatar	4.5	17	Brazil	1.5**
7	Algeria	3.7**	18	Gabon	1.4
8	Venezuela		19	Cameroun	1.1
9	Equatorial Guinea	3.6	20	Canada	1.0
Total Top 20		107.5			

**Source:* Garvet B (2007).
** "These figures, expressed in billion cubic meters (bcm) may include some venting as well due to unavailability of segregated data" (Garvet 2007).

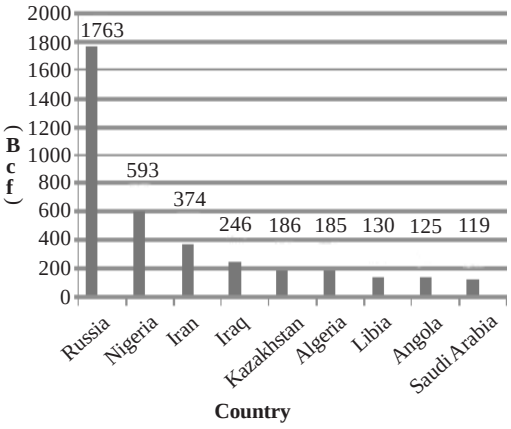

Fig. 3. Global gas flaring 2007
Source: National Oceanic and Atmospheric Administration in: EIA 2009

Table 2: The impact of gas flaring on agricultural output

Distance of farm land from flare site	*Percentage loss in yield of crops*
200 meters	100 percent
600 meters	45 percent
1 kilometre	10 percent

Source: Salau 1993: 19-22, Adeyemo 2000: 69 (Opukri CO, Ibaba IS 2008).

The flaring of gas results in the release of associated gases which have been linked to global warming and climate change. The release of greenhouse gases, particularly methane and carbon dioxide during flaring continues to contribute to the phenomenon called climate change and its attendant consequences. As Osuoka and Roderick (2005) assert, "the burning of fossil fuel, mainly coal, oil and gas-greenhouse gases- has led to warming up of the world and is projected to get much worse during the course of the 21st century, according to the Intergovernmental Panel on Climate Change (IPCC)" (p.19). With Nigeria continuing to contribute the greatest proportion of emitted greenhouse gases, when compared with that of the total combined sources from sub-Saharan Africa, the problems resulting from global warming are to say the least very grave indeed. The role of multinational oil companies in the exploration for crude oil in the Niger-Delta has remained contentious as a result of the activity of gas flaring that is perpetuated by these companies. Though the total amount of gas that is being flared has dropped from an all- time high of 49.8% (2000-2002 period) to around 26% in 2008; this figure still remains unacceptable in light of other oil producing countries returning figures of less than 1% (Fig. 4). The Shell Petroleum Development Company (S.P.D.C) continues to be the company with the highest flare percentages (28% in 2008). Mobil, NAOC, Chevron, Total, Texaco and Pan Ocean had figures of 21%, 20%, 19%, 8% and 2% respectively (Fig. 5). It must be pointed out that these companies have made some effort at reducing the amount of gas flared as can be seen in table 3. However, these reductions do not go far enough in terms of eliminating this unacceptable practice.

As Adeyemi (2000) observes, climate change would come with its surprises as a result of the difficulties in making predictions with regards to the future. However, the share complexity of this phenomenon and the impact on a rapidly

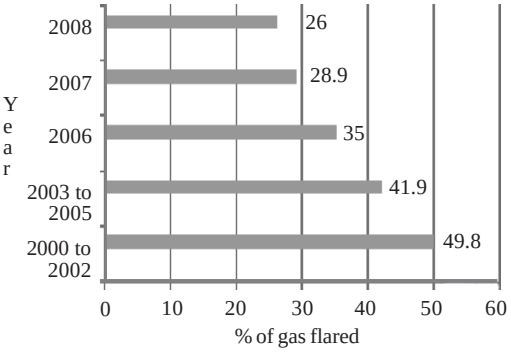

Fig. 4. Total Percentage of natural gas flared in Nigeria (200-2008)
Source: Madueme D 2010

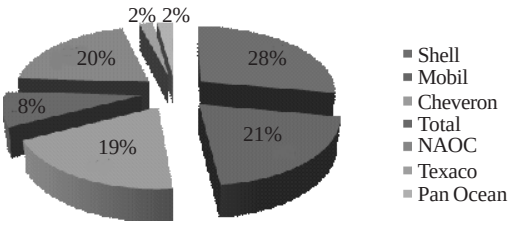

Fig. 5. The contributory percentage share of oil companies to gas flaring in Nigeria (2000-2008)
Source: Authors' analysis based on data computations from Table 4

growing population is not in doubt, as the tell–tale signs of global warming are already beginning to take effect in different regions of the world, although, with differing effects and consequences for the environments of these areas and the communities that reside within them. Gas flaring, and the impact on the inhabitants of the host communities where oil exploration continues to be practiced is not well documented with regards to the Niger-Delta as there has been no significant research into the impact of this activity on the health of the people of the affected area (Osuoka and Roderick 2005). However, in the areas where gas flaring continues, medical personnel continue to report ailments that could be linked to gas flaring: bronchial, chest, rheumatic and eye problems to mention but a few. According to the United States Environmental Protection Agency, "many scientific studies have linked breathing particulate matter to a series of significant health problems, including: aggravated asthma, increases in respiratory symptoms like coughing and difficult or painful breathing, chronic bronchitis, decreased lung function, and premature death" (p.24 in: Osuoka and Roderick 2005). Added to this is the specter of cancer as these flared gases contain quan-

Table 3: Major oil companies with data on natural gas produced and flared for the period 2000-2008

Name of company	*Year*				
	2000-2002	*2003-2005*	*2006*	*2007*	*2008*
Shell					
*Gas produced	1632857255	2114726414	735315476	783905871	800689383
*Gas flared	835756839	754786431	163405866	96967320	97879670
Mobil					
*Gas produced	1232323154	1159585960	491110702	464537132	427115491
*Gasflared	383175395	535622854	210026922	183528046	130586764
Cheveron					
*Gas produced	627587155	655500024	235249063	101186784	243040550
*Gas flared	455440050	389895189	192602299	162780356	1561952278
Total e & p					
*Gas produced	332525971	802855214	218968851	289817162	320372636
*Gas flared	123648616	265047845	64224402	33842081	96353534
Naoc					
Gas produced	1109643063	1244207143	423716209	320927714	293668636
Gas flared	587136497	496718413	109926431	108696157	96353534
Texaco					
*Gas produced	87486761	37025939	5941278	2479303	4803727
*Gas flared	87031562	36653106	5828277	2421926	4746874
Pan ocean					
*Gas produced	62940758	74517198	3944139	0.00	21752432
*Gas flared	59828073	70969973	3756324	0.00	21211546
GrandTotals					
*Gas produced	5085364117	6088397892	2114245718	2032853975	2111442905
*Gas flared	2532017032	2549693811	740770521	588235886	542732471
% of gas flared	49.8	41.9	35	28.9	26

Source: Madueme D (2010).
*Billion cubic feet (bcf)

tities of carcinogenic materials. This is underlined by the U.S.EPA which asserts that "it has been clearly established and accepted that exposure to benzene and its metabolites causes acute non-lymphocytic leukemia and a variety of other blood- related disorders in humans" (p.24 in Osuoka and Roderick 2005). Thus, the communities and people of the Niger-Delta region are in a battle for existence as the flaring of gas continues to assault their fundamental human rights as enshrined in the constitution of the Federal Republic of Nigeria; and disrupt the delicate ecological balance of their environment which has evolved over millions of years. The result of this degradation of the environment overtime has resulted in the communities in the areas affected agitating for compensation (Alakpodia 2000). This agitation has in turn spawned militancy in the form of attacks on oil facilities, kidnappings, assassinations and a general break down of law and order in the Niger-Delta; the violent agitations have in turn had an adverse (negative) effect on the country's oil production output thus resulting in dwindling revenue from crude oil sales (Ebiri 2010; Akasike and Adelakun 2010).

Table 4: Amount of and percentage share of natural gas flared by oil companies in Nigeria (2000-2008)

Company name	*Amount of gas flared*(bcf)*	*% share of gas flared*
Shell	1948796126	28.0
Mobil	1442939981	21.0
Cheveron	1356913172	19.0
Total E&P	583116478	8.0
Naoc	1398831032	20.0
Texaco	136681745	2.0
Pan ocean	155765916	2.0

Source: Authors' computation based on data from table 3.
* Billion cubic feet

4. CONCLUSION

The government of Nigeria set up the Liquefied Natural Gas (LNG) project to act as a tool for resource utilization and conservation through reducing to a minimum or stopping (totally) the practice of gas flaring. The environmental cost of oil exploitation is very great indeed. Thus; it is rather surprising that the activity of gas flaring continues unabated even with the existence of the necessary laws and institutions to stop this practice! It is, therefore, obvious that a resolution to this problem stems from a lack of political will on the part of the government to stop this harmful practice. The government of Nigeria needs to shift away from the current policy of fining erring companies as the cost of flaring far outweighs the current regimes of monetary fines; and this position is in tune with that of the World Bank. Thus, the emphasis should be that of discouraging (totally) the act of flaring gas by these companies and all measures including a flare-out or get-out policy should be considered if this practice is to be eliminated completely.

5. RECOMMENDATIONS

There is clear weakness on the part of the government to tackle this problem or there is connivance between the government and the oil companies to perpetuate this practice. It is also clear that the flaring of gas brings with it some social and economic cost to the host communities. Similarly, the continued flaring shows a colossal waste of resources especially in a country that continues to grapple with energy shortages. The gas being flared could be channeled towards meeting the ever increasing demand for energy in the industrial sector of the economy. There is also a strong market for this product internationally, and the country stands to rake in huge sums from the sale of this product to other countries who wish to satisfy their energy demands. Thus, what is required is self-realization and determination on the part of all stakeholders in the Oil and Gas sector to resolve this problem once and for all, in the interest of the local communities, the ecology of the affected areas, the economy of the country, and the global environment in general. This together with an integrated approach to transportation in the area would go a long way in improving on the sustainability of the entire region.

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