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Gas Flaring in Nigeria: Opportunity for Household Cooking Utilization

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Abstract

There is enough empirical evidence to support the notion that the flaring of associated gas in Nigeria by multinational oil firms contributes enormously to gaseous emissions and thermal radiation in Nigeria, especially in the Niger Delta region of the Country. The Federal government of Nigeria's efforts to stop gas flaring has been inadequate as deadlines handed down to oil companies over the years have failed to deter them from flaring gas. A total of 71 million m^3 of associated gas from oil exploration is flared on a daily basis without attracting attention from the media and the international community as against the recent British Petroleum (BP) saga in the United States which drew widespread attention from the media, the public and the shareholders of the company. The BP oil spill incident which was an accident forced BP into spending unbudgeted billions of dollars to appease the American people and to maintain the firm's integrity. Nigeria loses 2.5 billion dollars annually through gas flaring. Furthermore there are attendant environmental and socio-economic impacts of gas flaring on the people living in the immediate environment where the gas is flared. In this paper household cooking gas, in form of Liquefied Petroleum Gas (LPG) is proposed to reduce gas flaring and improve Nigeria's household cooking efficiency.

Keywords: Gas flaring, Environmental, Socio-economic, Government policy, Crude oil

1. Introduction

Gas flaring in Nigeria is not an accident; it is a calculated attempt to cut cost at the expense of the people and the eco-balance of the environment. One of the major consequences of the continuous release of associated gas into the environment is the greenhouse effect, a phenomenon that is attracting increasingly attention from all over the world. The recognition of the threat posed by the continued flaring of gas and adequate steps taken to remedy the problem will help protect the environment and the Nigerian people.

Nigeria's gas reserves (associated and non-associated gas) was estimated by D. Green in 1998 to be 3.36 trillion m^3 [1] but recent estimates stand at 4.0 trillion m^3 according to Sonibare et al [2]. The main oil exploration firms in Nigeria are Shell, ExxonMobil,Chevron,Texaco and TotalFinaElf. These firms flare a good proportion of the associated gas lifted with crude oil because of the lack of adequate infrastructure to supply the gas to possible end-users due to the fact that the recovery cost of associated gas is much higher than the cost for non-associated gas . These firms are basically profit oriented and have little concern for the environment and the Nigeria people.The environmental degradation witnessed in some of the areas where oil is explored in Nigeria is a thing of concern and an issue that needs immediate response from the federal government and the international community in order to preserve the lives and health of the people that live in the immediate oil exploration environment.

Crude oil exploration comes with associated gas that needs to be seperated before the oil is refined and there are three options for separating the associated gas. The first is to reinject the gas to the ground for future reuse,this option is used in developed nations of the world and requires infrastructure and mechanisms that are complex . The second is to use it for domestic and commercial puposes which will involve acquiring equipments for liquidification and transportation,the third and last option, which is the easiest is to flare the gas. Gas flaring is prohibited by law in most countries due to its harmful effect on the environment and the people except in unavoidable circumstances such as accidental breakdown of machinery, pipelines e.t.c,. The issue of gas flaring in Nigeria is largely due to poor technology and infrastructure, weak

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governmental policies to enforce harvesting the gas for domestic use or the reinjection of the gas into the ground. The oil firms have used the gross corruption among the political leaders to mitigate proactive enforcement of standard practices as is obtained in developed countries. Based on proven gas deposits, Nigeria is ranked 8th in the world and in terms of quantity of gas flared she is ranked 2nd according to figure 1&2.[3]

2. Household cooking energy pattern in Nigeria

In Nigeria, mostly in the rural areas, traditional fuels are used for cooking. Traditional fuels such as fuel wood, sawdust charcoal and agricultural waste and some petroleum products like kerosene and methane are the major fuel types used in household cooking. Nigeria can save vast amounts of energy from the use of available efficient technologies and fuel types for cooking, but the diffusion of these technologies and fuel types are not available to the general public due to:
(1. high cost of these fuel types particularly to the low incomes people in rural Nigeria and (2. lack of distribution network and infrastructures. There has been a huge depletion of the traditional fuel sources in Nigeria in recent years. The use of fuel wood for cooking by many households in Nigeria contributes greatly to deforestation, soil erosion, and desertification. It is estimated that over 400,000 hectares per year of fuel wood is used in Nigeria, if this trend continues the country's forest resources could be completely depleted by 2020 [4]. Aside the deforestation effect, fuel wood use also contributes to greenhouse gas emissions and it destroys an important CO_2 sink in the country.
Households in the urban areas depend heavily on kerosene as a fuel type for cooking. Many of these household have been forced to switch to traditional fuel sources due to the high cost of kerosene and its scarcity in recent time. Nigeria imports refined petroleum products (like petrol and kerosene) from foreign countries due to the poor state of its refineries. One major problem in the importation of kerosene is its high demand in the aviation sector. Kerosene which is also known as dual purpose kerosene (DPK) is also used as aircraft fuel. The energy sources in Nigeria are abundant and greatly diverse from non-renewable to renewable alike but the country has failed to manage its resources to benefit its populace. Table 1 and 2 show the non-renewable and renewable energy sources in Nigeria. Over the years the following are the most common forms of cooking energy in Nigeria: fuel wood, kerosene, liquefied petroleum gas (LPG) and electricity. Fuel wood and kerosene are in use in both the rural and urban settlements in Nigeria with few household using LPG or the electricity. Electricity form of cooking is not popular in Nigeria due to epileptic supply of electricity. Table 3 shows the findings of Anozie et al in 2004 on the Energy consumption and cost analysis for boiling 2.25 litres of water to evaluate the cooking energy cost, cooking energy consumption efficiency and cooking energy intensity. [5].

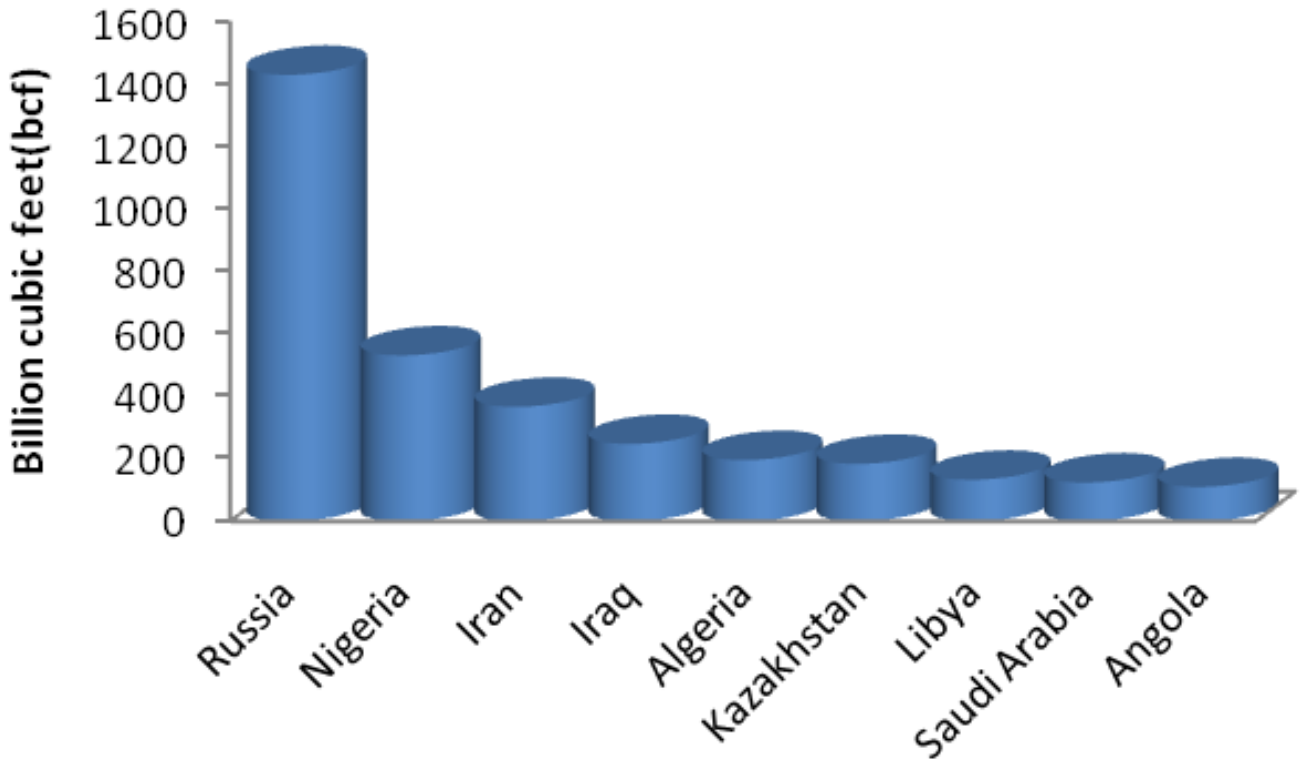

Figure 1. Gas Flaring by Country

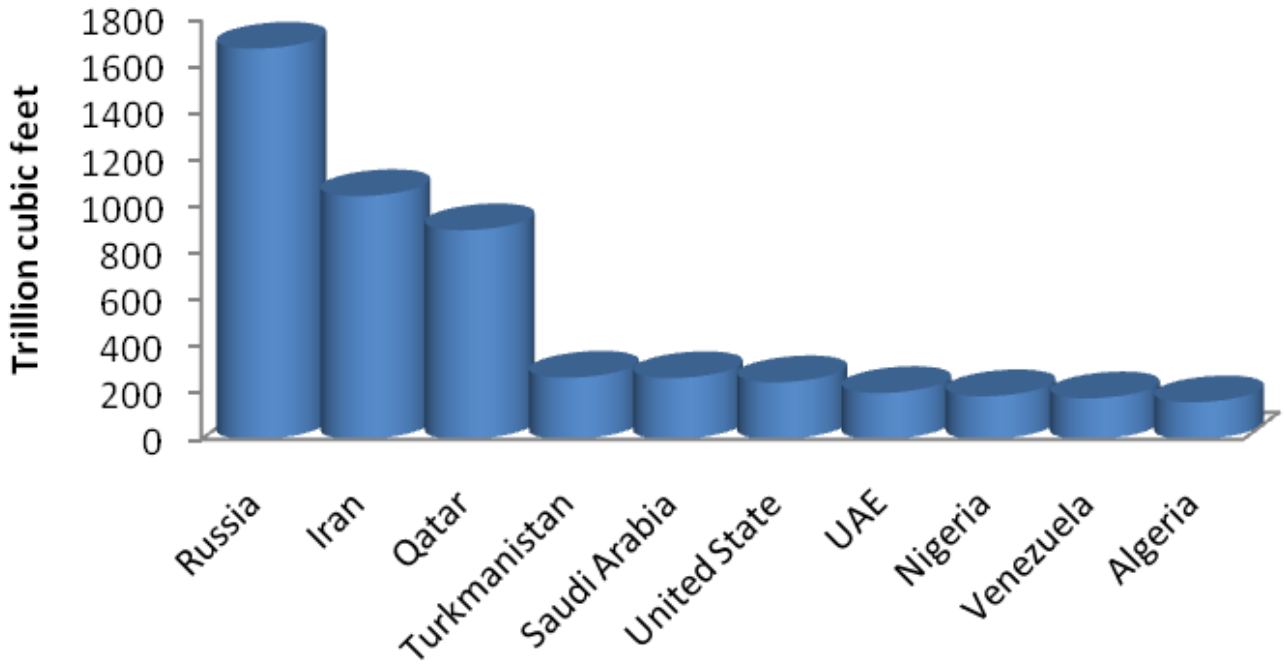

Figure 2. Top Proven Non-Associated Gas Reserve Holder

Table 1: Non-Renewable Energy Source in Nigeria [6]

Energy Type	Reserves Estimates
Crude oil	36 billion barrels
Natural gas	185 trillion cubic feet
Coal	2.75 billion metric tons

Table 2: Nigeria's Renewable Resources [7]

Energy	Sources
Hydropower, large scale	10,000MW
Hydropower, small scale	734 MW
Fuelwood	13,071,464 hectares (forest land 1981)
Animal waste	61million tones/yr
Crop Residue	83million tones/yr
Solar Radiation	3.5-7.0kWh/m2-day
Wind	2-4 m/s (annual average)

3. Gas Flare and Household gas utilization in Nigeria

Nigeria has been an oil producing state since the 1960's. The economy is run on crude oil revenue. Nigeria is an active member of OPEC and among the oil producing countries. Nigeria boasts the 8th largest proven natural gas reserves, produces over two million barrels of crude oil per day, and has been earning over the years, about $20 billion from oil revenues annually [4]. The gas flaring in the oil rich states of Nigeria have been ongoing since the early 1960s. It is estimated that through gas flaring about $2.5 billion in government revenues is lost annually and $72 billion for the period between the year 1970 to year 2006. There are current efforts by the government to use some of the flared gas for electricity generation but they are still at planning stages, some few private sector led power suppliers have constructed some gas power engines to complement the power generation by the government own utility supplier. Figure shows the gas production, utilization and flared since 1990 to 2006.

The Nigerian government has attempted ending gas flaring several times without a positive outcome, mainly due to poor policies and lack of enforcement regulation. The first attempt at forcing oil corporations operating in the Niger Delta to end flares was in 1969, the oil firms were mandated to put in place facilities that will utilize associated gas within five years of their commencement of operations. But five years after, the oil companies still had nothing on ground for gas gathering. The date for zero gas flaring was later shifted to 1979 when it was seen that the firms had nothing on ground to end gas flaring. The inability of the oil companies to meet the second deadline necessitated the third deadline of 1984 as the zero flare date. The government later introduced a fine to be paid by defaulters for flaring gas. The fine was viewed by the oil firms as more convenient and a cheaper alternative than putting in place structures to end the flaring. In addition, an Associated Gas Re-Injection Act of 1979 No 99 was introduced, demanding that oil corporations operating in Nigeria should produce detailed plans for gas utilization as well as guarantee zero flares by January 1, 1984**.** The shift in date continued from 1984 to 2008 and up till now gas flaring still continues in Nigeria.

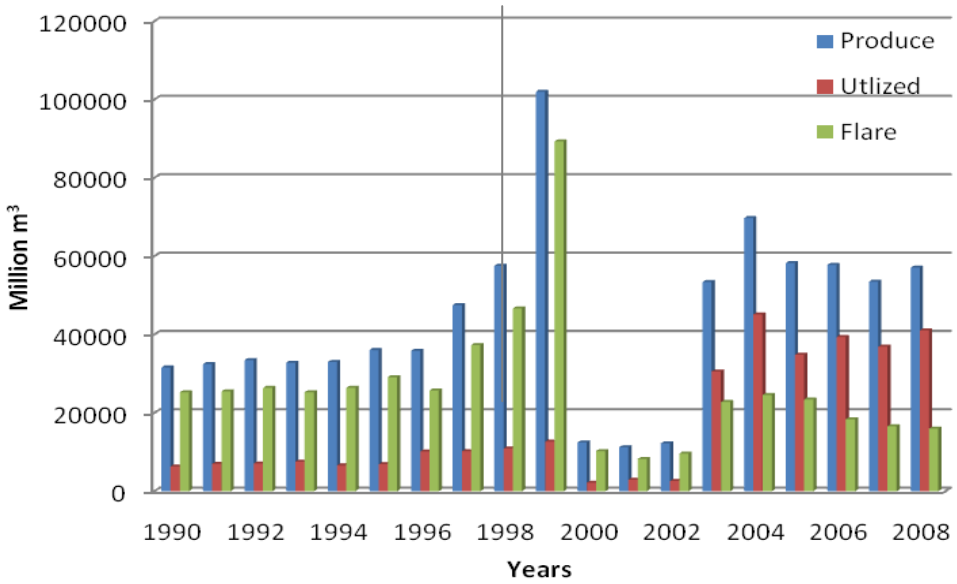

Figure 3. Gas production, utilization and flared since 1990 -2006

Table 3 Energy consumption and cost analysis for boiling 2.25 litres of water [7]

Energy source (Appliance)	Weight of Fuel used (g)	Time of boiling (min)	Water evaporated (g)	Energy consumed [a] (kJ)	Rate of heating (kJ/s)	Energy intensity (kJ/g of water)	Energy consumption efficiency [b] (%)	Energy Cost (Naira [c]) 1995	2001	2004
Fuel wood (Open air burning)	250[d]	38	110	3584	1.57	1.60	25	0.26	0.67	0.94
Kerosene (stove)	40	19	90	1880	1.60	0.84	46	0.31	1.03	2.82
Gas (cooker)	25	13	80	1150	1.47	0.51	73	0.60	3.00	3.60
Electricity [e] (immersion coil)	—	15	85	1080	1.20	0.48	79	0.15	0.78	1.20
Electricity [e] (external heating coil)	—	18	85	1296	1.20	0.58	66	0.18	0.94	1.44
Electricity [e] (hot plat)	—	13	80	936	1.20	0.42	90	0.13	0.68	1.04

[a] Estimated with percentage error of about 74%. [b] Estimated with error of about 73%. [c] Naira, Nigerian currency.
[d] Weight of charcoal left ¼ 90 g. [e] Electric voltage = 240 V, Electric current =5A.

The energy pattern in Nigeria shows that there is heavy reliance on fuel wood in the rural areas and kerosene in the urban areas in Nigeria. Table 4 presented the result of a survey on energy pattern in both rural and urban areas in Nigeria. The option of electricity for cooking in Nigeria is not attractive due to inconsistency in the way power is rationed. In fact it is not an option in the rural areas because most of the rural areas are not connected to the national grid. It will be observed from Table 4 that Kerosene as an energy source has attracted a lot of households in Nigeria due to its low price and availability until recently when its price skyrocketed and it became a scarce commodity for most households. The LPG have not gained wide acceptance in Nigeria due to high price. This paper propose government's involvement in converting the gas flared in the Niger delta region to a useful cooking energy source by improving on the infrastructure that will make this commodity available to every household at a cheap price. The gas flared by Nigeria can be converted to LPG and transported to every part of the country.

Table 4 Random sample survey of urban and rural energy use pattern in Lagos State, Nigeria

Energy source	Urban pattern (%)	Rural pattern (%)
Fuel wood	13	61
Charcoal	11	7
Kerosene	57	30
LPG	26	2
Electricity	7	-
Total	100 %	100 %

Table 5 shows the potential daily gas consumption of households in different parts of the country, covering both the rural and the urban areas in Nigeria. If the government can afford to waste the gas by allowing the oil firms to flare without any serious consequences, then the general populace can take advantage of associated gas for household cooking purposes. The flared gas if utilized for household cooking energy will not only reduce gas flaring but will increase the domestic earning of the government and improve the life of the Nigeria people.

4. Policies Recommendations

It is clear from this paper that the energy policy in Nigeria as regards gas flaring has not been effective, and that the government has also failed to utilize the waste gas for its economic benefit by providing infrastructure that will enable the flared gas to be used for household cooking purposes. This will reduce/eliminate the consumption of other cooking forms of energy like fuel wood and kerosene thereby ensuring a cleaner atmosphere. The recent importation of kerosene in the country involves a lot of subsidy from the government, this subsidy will not be necessary in the first place if the energy policies of the government have included the use of flared gas for domestic cooking. The government needs capacity building strategies like the following:

(1) The government should enforce zero flaring of gas in its entire oil rich region by converting the associated gas into LPG and make it available for domestic purposes like cooking. LPG is more environmentally friendly than fuel wood or kerosene and can be transported through pipelines and can also be safely bottled as compressed gas and sold to households. It is obvious from Table 5 that household consumption of gas will reduce gas flaring in the Niger Delta oil producing area.

(2) There is a huge opportunity for gas plants in Nigeria; the government should increase its involvement in electricity generation through the use of its abundant gas.

(3) The government should introduce heavy financial sanctions on any oil exploration firms that fail to comply with its regulations. The revenue from these financial sanctions should be used to improve infrastructure that will end the gas flaring.

(4) The various commissions charged with the responsibilities of overseeing the energy sector in Nigeria should be overhauled. The Nigeria Energy Commission should be adequately empowered to coordinate and monitor the implementation of energy policies.

(5) The National Centres for Energy Research should collaborate with the Universities of technology in the country for knowledge and research sharing to help the development of energy technologies in Nigeria.

(6) The government should completely disengage itself from ownership and management of energy related companies.

(7) Indigenous Private Nigerian companies should be encouraged to participate in the formulation of energy policies.

5. Conclusion

The paper has reviewed efforts by the government to end gas flaring and has proposed another means of utilizing the gas flared. These utilization proposals will reduce or end the routinely flared associated gas if implemented. Past attempts to eliminate routine flares in the country can be seen to lack enforcement and implementation by the government and the oil firms. It can be concluded that past prescription of very small penalties by the promulgated acts with non-availability of utilization projects, like converting the flared gas into LPG for household consumption, make these efforts unsuccessful.

The use of the associated gas for LPG and domestic consumption for electricity generation and other industrial activities are projects capable of utilizing the flare gas for economic benefit. This work also shows that there exists a potential for domestic utilization through households. Table 5 shows that an amount in tune of 13,575,072 m^3 of flared gas can be consumed by household on daily bases for cooking. The work also recommends the use to flared gas in electricity generation.

The volume of gas required to power gas plants to meet the electricity demand in the country can be provided for by the wasted gas in flames. The welfare of households will be improved if gas pipelines and other infrastructure can be put in place to make the gas available in every household. This will increase the domestic earning of the government and Nigeria can be a gas exporting country to her neighbours.

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Table 5: Potential daily gas consumption by Household in Nigeria

State	Population [a]	Number of Household [b]	Potential daily gas consumption (m^3) [b]
Abia	2,845,380	474,230	275,503
Adamawa	3,178,950	529,825	307,230
Akwa Ibom	3,902,051	650,342	377,198
Anambra	4,177,828	696,305	403,857
Bauchi	4,653,066	775,511	448,796
Bayelsa	1,704,515	284,086	164,770
Benue	4,253,641	708,940	411,185
Borno	4,171,104	695,184	403,207
Cross River	2,892,988	482,165	279,656
Delta	4,112,445	685,408	397,537
Ebonyi	2,176,947	362,825	210,439
Edo	3,233,366	538,894	312,559
Ekiti	2,398,957	399,826	231,899
Enugu	3,267,837	544,640	315,891
Gombe	2,365,040	394,173	228,620
Imo	3,927,563	654,594	379,666
Jigawa	4,361,002	726,834	421,564
Kaduna	6,113,503	1,018,917	590,972
Kano	9,401,288	1,566,881	908,791
Katsina	5,801,584	966,931	560,820
Kebbi	3,256,541	542,757	314,799
Kogi	3,314,043	552,341	320,358
Kwara	2,365,353	394,226	228,651
Lagos	9,113,605	1,518,934	880,982
Nasarawa	1,869,377	311,563	180,707
Niger	3,954,772	659,129	382,295
Ogun	3,751,140	625,190	362,610
Ondo	3,460,877	576,813	334,552
Osun	3,416,959	569,493	330,306
Oyo	5,580,894	930,149	539,486
Plateau	3,206,531	534,422	309,965
Rivers	5,198,716	866,453	502,543
Sokoto	3,702,676	617,113	357,926
Taraba	2,294,800	382,467	221,831
Yobe	2,321,339	386,890	224,396
Zamfara	3,278,873	546,479	316,958
FCT Abuja	1,406,239	234,373	135,936
Nigeria	**140,431,790**	**23,405,298**	**13,575,073**

[a] Source : National Population Commission of Nigeria (2006 censure).
[b] Source : Calculated by the authors.