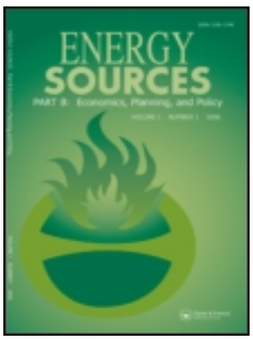

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Economics and environmental impacts of oil exploration and exploitation in Nigeria

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ABSTRACT

Exploration and exploitation of oil in Nigeria since the discovery of oil in the commercial quantities in 1958 have sustained the country economy and contributed greatly to the enhancement of its citizenries' well-being. However, the negative impacts of the introduction of unwanted byproducts into the ecological system during oil exploration and exploitation by way of relentless flaring of gas and oil spillage cannot be ignored. This present study, therefore, reports the economics and environmental impacts of oil exploration and exploitation in Nigeria. Data were collected and analyzed on the volume of gas produced and flared in Nigeria between 1970 and 2010; also collected are the barrels of oil produced between 1970 and 2020 and the average price of barrel oil and gallon of gas between the said period. Results of analysis indicate that about $669 billion was generated from the sales of crude oil between 1970 and 2010. Analysis of the collected data also showed that, between 1999 and 2010, 742,983,000 m^3 of gas was produced, equivalent to $192 billion if harnessed and 587,375,000 m^3 flared, representing $151.3 billion loss of revenue. The exploitation and exploration of oil therefore not only are a source of revenue for the country but also contributed greatly to the pollution of the environment and the need to collect the gas for effective utilization.

KEYWORDS

Crude oil and associated gas; economics; gas flaring; oil exploration and exploitation

1. Introduction

Crude oil is undoubtedly the main backbone of the Nigerian economy, its discovery and exploration had introduced a considerable development in the country both financially and technologically. Major deposits of Nigeria crude are found in the Niger-Delta area of the country. The exploitation and exploration of oil have created some fortunes and contributed positively to the economy and technological advancement of the country as a whole. For instance, it has been reported that oil exploration and exploitation in Nigeria provide 80% of the Nigerian revenue and 90% of its foreign exchange (Ageh et al., 1999; Abdulkareem and Odigure, 2002; Abenege, 2004). However, the accompanying socioeconomic and ecological fallout of oil exploration and exploitation is enormous. The activities of oil-producing companies operating in the Niger-Delta area of Nigeria resulted in various forms of environmental pollution, by way of relentless flaring and venting of gas to the environment, oil spillage, site clearing, deforestation and destruction of flora and fauna, and ecological disturbance in the 70 km^2 Niger-Delta wetlands (Ajayi, 1999; Olukoga, 2002; Akpan, 2009; Agbalino and Eyinal, 2009). Oil spillage is considered the most significant source of pollution from the petroleum industry because its effects are visible. Petroleum and it components released into the environment eventually degrade into both simple and complex compounds of their

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constituent elements by physical, physio-chemical, and biological agents, which may cause serious damages to the environment and impede human exploitation of natural resources (Abowei et al., 1997; Sanusi, 2004; Tolulope, 2004). Hence, the effects of oil spillage cannot be overemphasized and to be able to deal with the threat of oil spill quickly, Nigeria's Environmental Protection Agency (EPA) created the oil spill program (OSP) being run under the supervision of the EPA's emergency response program of the superfund. The OSP has been able to reduce the number of spills to less than 1% of the total volume handled each year (NOAA, 2008). However, the need for continued oil spill prevention and reduction is the desired interest of environmental interest groups, immediately affected communities, and the government alike. Gas flaring is another major problem associated with oil exploration and exploitation, considering the serious deterioration of the basic characteristics of the environment as a result of harmful pollutants being released into the air through gas flaring. The harmful effect of gas flaring on the host communities and the inability of the oil-producing companies and the government to quantify the resultant effect of gas flaring have resulted in a violent relationship among the oil companies, government, and the host communities. It can be inferred therefore that both environmental and economic drives can be identified as the motives behind several attempts by the government at eliminating natural gas flares in Nigeria. For instance are the promulgation of decrees and introduction of incentives for companies involved in downstream gas utilization to discontinue flaring of associated gas at well head, but none can be said to be fully successful so far (ESMAP, 2004; Abdulkareem and Odigure, 2010). This present study therefore reports the economic and environmental impacts of oil exploration and exploitation in Nigeria.

1.1 *Gas flaring*

Gas flaring is a widely used practice for the disposal of associated gas in oil production and processing facilities where there is insufficient infrastructure for utilization of the gas (primarily methane). The gas emerges from crude oil when it is brought to the surface and is separated from the oil prior to transport. Flaring activities have been linked to global warming. Global warming or climate change is a measurable increase in the average temperature of the Earth's atmosphere, oceans, and landmasses (Lee et al., 2007; Mathew, 2007; Soylu, 2007; Tzimas et al., 2007; Abdulkareem and Odigure, 2010). Scientists believe the Earth is currently facing a period of rapid warming brought on by rising levels of heat-trapping gases, known as greenhouse gases, in the atmosphere. Gas venting and gas flaring activities release huge amounts of greenhouse gases into the atmosphere. This activity has negative consequences on the environment such as flooding and reduced agricultural outputs. With this in mind, the need to control, regulate, and, if possible, end flaring cannot be overemphasized. Estimates suggest that of the 3.5 billion cubic feet (100,000,000 m^3) of associated gas produced daily, 2.5 billion cubic feet (70,000,000 m^3), or about 70%, is wasted by flaring. This equals to about 25% of the UK's total annual natural gas consumption, and 40% of Africa's gas consumption in 2001 (Abdulkareem and Odigure, 2010). It has been reported that the gas flaring costs Nigeria about $2.5 billion a year, with the waste reportedly enough to meet the electricity needs of the entire African continent. The reason for this economically and environmentally costly practice is that it is expensive to separate commercially viable associated gas from the oil. Akpan (2009) suggested that the only way out for harnessing the nation's natural gas is to encourage the establishment of gas-based petrochemical complexes that can consume the large volumes needed to eliminate gas flaring. In the same vein, Abdulkareem and Odigure (2010) worked on the economic benefit of natural gas utilization in Nigeria based on a case study of the food processing industry. Their work focused on the measurement of heat radiation from gas flaring as one of the menaces of gas flaring and the benefits of substituting conventional fuel and energy types, such as automotive gas oil (automotive gas oil-diesel), low pour fuel oil, and electricity with natural gas in monetary terms using mathematical principles in calculation with a case study of the food processing industry in Nigeria. Results obtained revealed that up to 69% on diesel, 29.85% on low pour fuel oil, and 69% on electricity could be saved by the company, translating to millions of dollars in five years if conventional fuel and energy are substituted with natural gas. Statistics about gas flaring in Nigeria and its impact on the environment are staggering. According to the National Oceanic and

Atmospheric Administration (NOAA, 2008), Nigeria flared 532 Bcf of natural gas in 2008, down from 593 Bcf in 2007. Although there are no current estimates as to the cost of flaring the natural gas, in 2007, the Nigerian National Petroleum Cooperation (NNPC) claimed that flaring cost Nigeria US$ 1.46 billion in lost revenue; however, critics consider that amount of revenue lost due to gas flaring is more than the amount quoted by the NNPC, since oil production levels determine the amount of associated gas produced, and thus bear on the amount of flaring. The rate and level of connection were summarized in a June 2001 speech by SPDC's former Chief Executive, Mr Basil Omiyi, where he stated that "*On the average, about 1,000 standard cubic feet (scf)* of *gas is produced in Nigeria with every barrel of oil. Therefore, with oil production of some 2.2 million* barrels *per day, about 2.2 billion scf of associated gas* is *produced every day.*" With unreliable information on oil production levels, and conflicting information on associated gas production levels, it is difficult to be confident about flaring volumes in Nigeria. However, having reviewed the available statistics, this paper will present a comparative analysis on the flaring activities of three selected multinational oil and gas companies operating in the Nigerian oil and gas upstream sector.

2. Methodology

This study involved the collection and analysis of data on crude oil production in Nigeria between 1970 and 2010. It also involves the analysis of data on gas production and flaring during the same period with the aim of predicting the amount of revenue generated through the exploitation and exploration of crude oil in Nigeria. Data were also collected on the volume of associated gas produced and the volume flared by multinational oil companies operating in the oil-producing region of Nigeria. Economic analyses were conducted on the revenue generated from the sales of crude oil and loss of revenue due to flaring of associated gas; these analyses were based on the average selling price of the crude oil per barrel and price per gallon of gas per year.

3. Results and discussion

Before the discovery of oil in Nigeria, agriculture was the cornerstone of the country economy; Nigeria then depends on the exportation of agricultural products such as cocoa, cotton, groundnut oil, and palm oil to sustain her economy. In fact, Nigeria was ranked second in the global production of cocoa and it is pertinent to mention here that the production rate of cocoa in Nigeria between 1975 and 1976 fell by 60% due to oil boom (Sanusi, 2003). The discovery and exploration of oil in the Niger-Delta area of Nigeria in 1958 therefore led to a gradual shift of the Nigerian source of revenue from agriculture to oil and in the early 1970s the oil business dominated the country's economy (Abdulkareem and Odigure, 2010). Presently, Nigeria is the largest producer of oil in sub-Saharan Africa and today about 80% of the Nigerian foreign revenue comes from the sales of oil (Abenege, 2004). It is worthy of mentioning that commencement of oil exploration and exploitation and in turn the establishment of the energy sector based on the quantity of crude deposit discovered have contributed immensely to the development of the Nigerian economy. However, the accompanying environmental pollution such as gas flaring and oil spillage is of great concern and also a source of faceoff between the oil industries and the host communities of the Niger-Delta area of Nigeria. The impact of gas flaring is of both local and global environmental concern (Ajayi 1999), since the pollutants resulting from the flaring activity adversely affect the health of humans and animals and also cause plant and material damage, including environmental disorderliness (Abenege, 2004). This present study therefore assessed the economic and environmental impacts of oil exploration and exploitation in Nigeria relative to the quantity of gas flared and crude oil production. Data collected and analyzed on the volume of gas produced and flared are presented in Figure 1 and Table 1. It can be observed from the results presented that a large volume of gas was flared by the oil companies between 1970 and 2010. It can be seen from the results presented in Figure 1 that the least percentage flared of 46.73% was recorded in 1988 (representing 12.9 million (m^3) gas flared out of 26.3 million (m^3) produced), while the highest percentage flared of 99.20% was recorded in

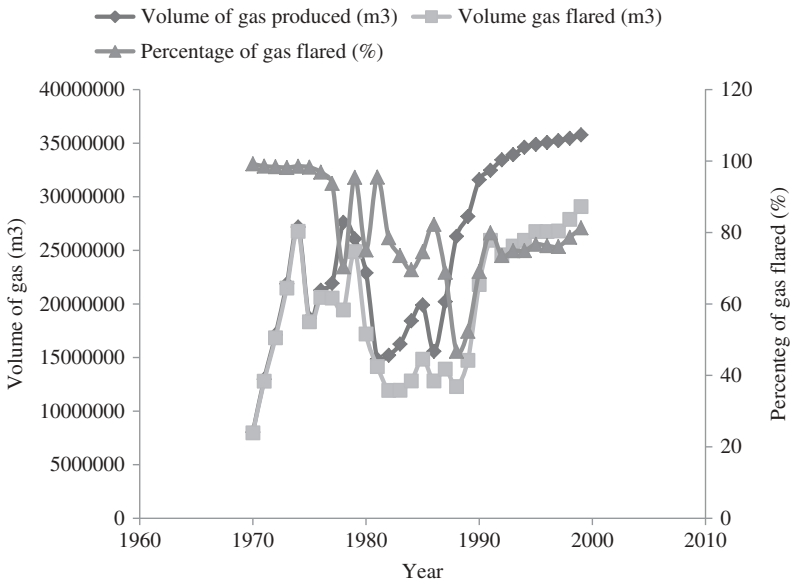

Figure 1. Quantities of gas produced and flared in Nigeria between 1970 and 1999 (Abenege, 2003).

Table 1. Nigerian associated gas production and flaring by three major companies 1999–2007, (mmscfd) (NGC).

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Company A	369	511	598	527	703	740	671	735	843
Production									
Flared	262	301	321	212	262	275	216	163	106
%	71.2	58.9	40.2	37.4	37.2	32.1	32.3	22.2	12.6
Company B	405	422	431	378	320	392	446	491	517
Production									
Flared	100	123	135	123	181	174	179	64	239
%	24.7	29.3	31.3	32.8	56.5	44.6	40.2	13.1	46.3
Company C	202	214	216	197	207	209	238	235	209
Production									
Flared	198	204	148	103	128	125	136	192	178
%	97.8	95.3	68.6	52.2	61.9	59.6	57.3	81.9	84.8
Total AG Production	976	1,147	1,245	1,102	1,230	1,339	1,335	1,461	1,569
Total AG Flared	560	628	604	438	571	574	531	419	523

1970, translating to 7.97 million (m^3) flared gas out of the 8.039 million (m^3) produced. Data of flaring activities of the selected three major oil companies (used as case study) in Nigeria over a period of seven years was also collected and analyzed as presented in Table 1. The analysis of data collected reveals that company A has the best record in terms of flaring activity when compared to the others. The results presented show that while the rate of associated gas production increases, the volume of flared gas reduced significantly although there is inconsistency in the pattern of the decrease. For instance, in 1999, company A flared 71.2% of its total production, while in 2007 the figure was put at just 12%. This is a commendable achievement for a seven-year period. Unfortunately, the story is totally different in the case of the other two. The report from company B is unpalatable because while associated gas production remained fairly consistent, the volume of gas flared increased, although it reached a minimum of 64 mm Bcf/d in 2006. Results also reveal that company C has much room for improvement given that in 1999 it flared 198 mm Bcf/d and in 2007, the figure stood at 178 mm Bcf/d, a mere 10% reduction in flaring activity over the seven-year period investigated. Therefore, the flaring of gas in Nigeria is not just sources of environmental pollution but also an economic waste as presented in Figure 2.

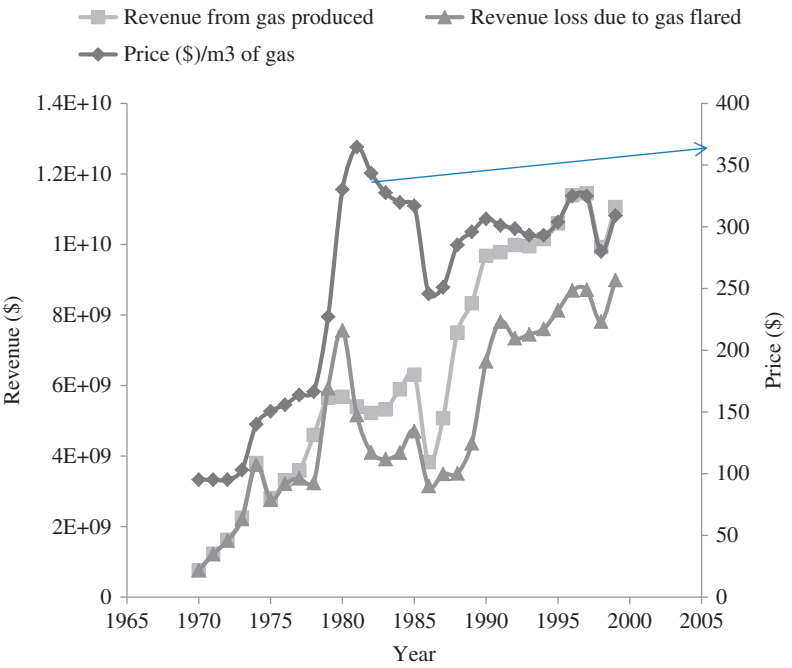

Figure 2. Revenue from associated gas produced and flared.

Analysis of the data presented in Figure 2 indicates the revenue to be generated if all the gas produced were utilized and the corresponding loss in revenue due to flaring. Analysis of data as presented reveals that Nigeria could have generated $790 million in 1970 if all the associated gas produced were to be harnessed, but due to flaring of associated gas $759 million dollars in revenue were lost. Results as shown in Figure 2 also reveal that revenue equivalent of $8.99 billion dollars was lost in 1999 due to gas flaring. The flared gases that contribute immensely to air pollution are of great economic importance. For instance, the flared gases can be redirected into pipelines for domestic utilization in cooking and electricity power generation. This natural gas can serve as a feedstock to chemical and petrochemical industries to manufacture intermediate chemicals and finished product, such as ammonia, oxo-alcohols, methanol, fertilizer, etc. It can also be utilized by food industries for spray drying of coffee, milk products, etc. There is therefore the need to utilize the gas produced during the exploration and exploitation of oil in Nigeria instead of flaring.

The analyses presented in Figure 3 show the quantities of crude oil produced in Nigeria between 1970 and 2010 and the revenue generated from the sales of crude oil based on the price per barrel of the oil (Figure 3). These results, which represent the price per barrel of oil and price per gallon of gas, show that the price of the two commodities is not stable over the years. This observation can be attributed to the fact that just like any commodity, the price of crude oil and gas varies according to the market forces, i.e. demand and supply and market policy and politics. The politics include formation of OPEC in 1960 with five founding members (Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela) and by the end of 1971 the membership increased to 11 including Nigeria. It was in the same year that the power to control the price of crude shifted from America to OPEC. For instance, the prices of crude oil doubled between 1977 and 1981; in 1971 the price per barrel was $14 and jumped to $35 per barrel. This was because of the strained relationship between Iran and Iraq and the Iran revolution, which resulted in a serious drop in quantities of oil supplied to the market by the two nations. It can be inferred from the aforementioned history that both the politics and the security situation of the oil-producing nations greatly affect the price of crude, as can be seen from the results that the price per barrel of crude in 2010 was $71.2 per barrel.

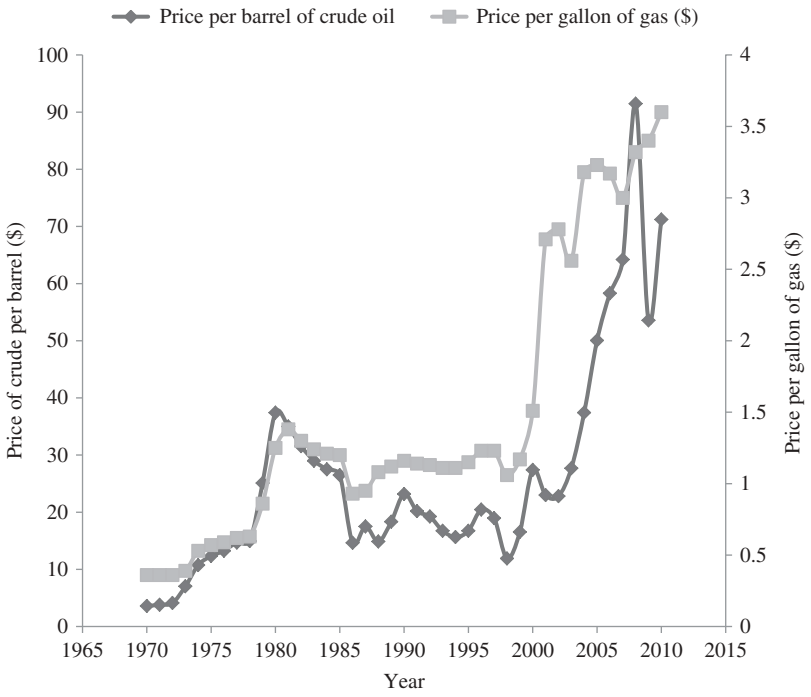

Figure 3. Price per barrel of crude oil and gallon of gas.

The quantities of oil produced in Nigeria and revenue generated are presented in Figure 4. The data was generated on the assumption that the production time was 300 days per year. As elucidated earlier, the price of crude oil behaves just like any other commodity with wide changes in price during shortage or oversupply. There is the widespread speculation of the possibility of crude oil price to continue to increase over several years while responding to demand, world politics, and political/security situation of the oil-producing nations. It can be seen from the results obtained that the production rate varies per year and so

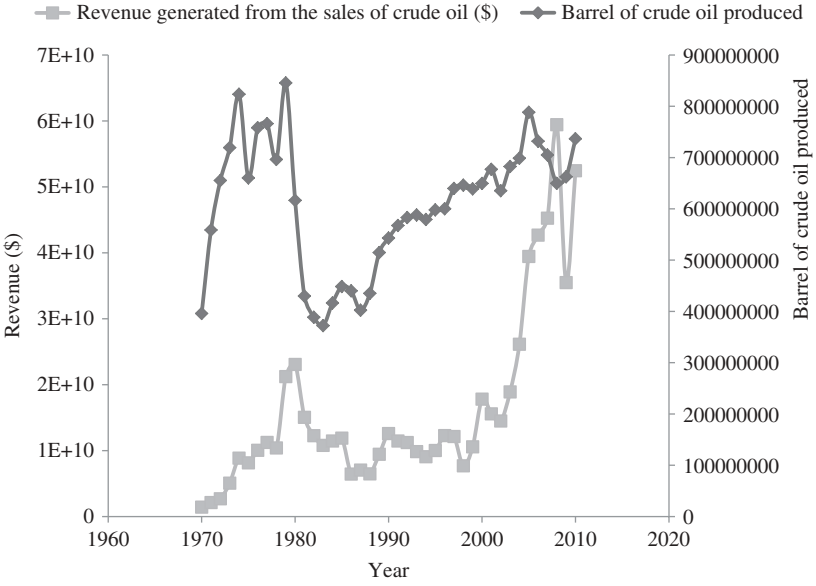

Figure 4. Crude produced per year and revenue generated.

also the revenue generated from the sales of crude oil. For instance in 1970, the production rate of crude oil was 3.96×10^8 barrels, which is equivalent to a revenue generation of $1.43 billion, while in 2010 the production rate was 7.37×10^8 barrels, equivalent to a revenue generation of $52.4 billion. Despite the facts that the difference in the rate of production was not much, the difference in terms of revenue generation was huge, as a result of the wide margin in the price of oil in 1970, which was $3.6 per barrel, and $71.2 per barrel in 2010.

4. Conclusion

Based on the collection and analysis of data on the production of oil in Nigeria, it can be inferred that the exploitation and exploration of oil have benefited the country immensely in terms of revenue generation. However, it has caused some environmental and economic wastage. Analysis of data on the production rate of oil between 1970 and 2010 revealed that oil exploitation and exploration in Nigeria led to the generation of revenue totaling $669 billion from the sales of crude oil. Analysis of the collected data also shows that, between 1999 and 2010, 742,983,000 m^3 of gas was produced, equivalent to $192 billion if harnessed and 587,375,000 m^3 flared, representing $151.3 billion loss of revenue. Considering the volume of gas flared, it can be inferred that exploitation and exploration contribute to environmental pollution. It is therefore important to harness the gas for economic purposes rather than flaring of the gas into the environment.

References

Abdulkareem, A. S., and Odigure, J. O. 2002. Radiative heat evaluation from gas flaring by computer simulation. *J. Assoc. Adv. Model Simul.* 72:1–10.

Abdulkareem, A. S., and Odigure, J. O. 2010. Economic benefit of natural gas utilization in Nigeria: A case study of the food processing industry. *J. Energy Source Part B* 5:106–114.

Abenege, S. O. 2004. *Modelling of pollutant dispersion from gas flaring: A case study of Niger-Delta Area*. B. Eng. Thesis, Department of Chemical Engineering, Federal University of Technology, Minna, Nigeria (unpublished). 1–48.

Abowei, M. F. N., Susu, A. A., and Onyeme, J. O. 1997. *Oil Spill in Marine Environment*. Lagos, Nigeria: CJC press (Nigeria) Ltd.

Agbalino, S. O., and Eyinal, B. 2009. Oil exploitation and marine pollution: Evidence from Niger-Delta, Nigeria. *J. Hum. Ecol.* 28:177–182.

Ageh, E. A., Akpan, O. U., and Okoro, U. J. 1999. Flared gas management. *Proceedings of 29th Nigerian Society of Chemical engineers (NsCHE)*, Port- Harcourt, Nigeria, pp. 1–7.

Ajayi, O. M. 1999. *Impact of gas flaring on the Niger-Delta area (a case study of Port-Harcourt Metropolis)*. B.Eng Thesis, Department of Chemical Engineering, Federal University of Technology, Minna, Nigeria (unpublished). pp. 10–26.

Akpan, S. 2009. The production and utilisation of Natural gas resources in Nigeria: A review. *Nigerian Annual International Conference and Exhibition in August of the Society of Petroleum Engineers in Abuja*, Nigeria, 2009.

Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP). *Strategic Gas Plan for Nigeria*, February 2004.

Lee, F. C., Lin, J. C., Lewis, C., and Chang, F. Y. 2007. Effects of carbon dioxide taxes on different industries by Fuzzy goal programming: A case study of the petrochemical related industries, Taiwan. *J. Energy Policy* 35:4051–4058.

Mathews, J. 2007. Seven steps to curb global warming. *J. Energy Policy* 35:4247–4259.

National Oceanic and Atmospheric Administration. 2008. 13 May 2008. Available at: <http://www.noaa.gov/>

Olukoga, E. A. 2002. Natural gas as a vehicular fuel. *Nigeria Gas Association International Gas Conference Exhibition*, Abeokuta, Nigeria, pp. 22–26.

Soylu, S. 2007. Estimation of Turkish road transport emissions. *J. Energy Policy* 35:4088–4094.

Sanusi, J. O. 2003. Overview of Goverment's Efforts in the Development of SMEs and Emergency of Small and Medium Industries Equity Investment Scheme (SMIESIS). Presesnted at the National Summit on SMIEIS by the Bankers' Committee and Lagos Chambers of Commerce and Industry. Lagos State, Nigeria

Sanusi, S. 2004. Mathematical Modelling and Computer Simulation of Oil Spillage in Soil. B.Eng Degree Project Unpublished. Federal University of Technology, Minna, Niger State, Nigeria, pp 1–53.

Tolulope, O. A. 2004. Exploration and environmental degradation: The Nigerian experience. *Environ. Info. Arch.* 2:387–393.

Tzimas, E., Mercier, A., Cormos, C., and Peteves, S. D. 2007. Trade-off emissions of acid gas pollutants and of CO_2 in fossil fuel power plants with carbon capture. *J. Energy Policy* 35:3991–3998.