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SUSTAINABLE INFRASTRUCTURAL DEVELOPMENT IN NIGERIA'S GAS SUB-SECTOR: A SUPPLEMENTARY EARNINGS PLATFORM AGAINST DWINDLING OIL PRICE

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Abstract
Alternative investment in infrastructure in the Nigerian gas sub-sector is expected to enhance sustainable development in that sector and relieve the economy of the shock arising from sharp fluctuations in oil price at the international market. Nigeria is one of the largest producers of natural gas, but lack of investment in technological infrastructure is a hindrance to the development of the gas sub-sector where global demand for gas is rising. Besides, gas flaring is an unscientific economic waste, the appropriate management of which should yield extra foreign earnings. The objective of this paper is to underscore the economic significance of infrastructural investment in the Nigerian gas sub-sector for sustainable development as well as a supplementary source of national earnings for the economy. The paper adopts a case analysis, focusing on Nigeria. The paper also explores conceptual frame work which is hinged on sustainable development. Observations reveal that the domestic market for gas is yet to be fully explored in spite of government's collaborative efforts in promoting the domestic use of gas. Similarly, awareness of the economic significance of gas is relatively low. In conclusion, while most advanced countries which are producers of natural gas have devised the technology for adequate storage and distribution of gas thus reducing gas flaring to the barest minimum, for a developing country like Nigeria, infrastructure provision and maintenance in the sub-sector is a problem. The paper recommends the participation of foreign technical partners in investment in infrastructure, storage and distribution in the gas sub-sector. Further studies can still be conducted to determine the economic returns and frequency of industrial and domestic consumption of natural gas in a gasrich environment.

Keywords: *Infrastructure, Sustainable Development, Gas Flaring, Energy*

Background to the Study

Nations that rely solely on the production, exportation and sale of only one commodity are prone to periodic shocks, especially where they have no adequate infrastructure to boost the production of a supplementary product. The Nigerian economy depends largely more on the oil sector for its foreign exchange earnings. This suggests that attention should be given to the development of

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infrastructure in the sector. Oil is subject to both fluctuations in price at the international market and quota prescriptions by the Organization for Petroleum Exporting Countries (OPEC) (Onwe, 1999).

Volatility in oil pricing was unexpectedly demonstrated in December 2014 when oil price dropped from 73 US dollars to 62 US dollars per barrel after a long period of average oil price of between 90 and 110 US dollars per barrel (Akinyele, 2015). By January, 2015, oil price per barrel was 51.78 US dollars (Aiyela, 2015). But thereafter, the price fluctuated consistently between 43.88 US dollars and 41.20 US dollars. The sharp drop in oil price has negative financial implications for developing OPEC members (like Nigeria) which base their budget projections on earnings from the oil sector. This development is a warning sign indicating that efforts should be channeled to alternative sources of foreign exchange earnings. For Nigeria, there is a significant drop in revenue and, expectedly, a reduction in capital expenditure is to be anticipated.

Furthermore, the frequency or periodicity of oil price slides is a major constraint to the implementation of government's short term economic plan and pursuit of budget objectives (Aiyedun, 2007). Such economic dislocations necessitate a shift in focus to a complementary commodity to engender balanced socio-economic development. It is in this light that the Nigerian gas sub-sector is being examined, considering the potential of the sub-sector to generate as much revenue for the government as well as provide an alternative source of electricity for industrial and domestic consumption.

There is growing demand for liquefied natural gas (for which Nigeria is a large producer) at the international market. As it is assumed in some quarters in the Western world that oil would be replaced by gas in future as an alternative source of global energy, the assumption constitutes a threat to oil producing and exporting countries. Nigeria is rich in gas reserves, but gas flaring has become a phenomenal waste of resources and loss of perceived substantial national revenue. It is presumed that Nigeria possesses about 189 trillion cubic feet of natural gas reserves (Omotowa, cited in Olanrewaju, 2014). Indeed, Nigeria's gas plants produce over 22 million metric tons of gas annually (Okere, 2015). Moreover, the production of liquefied natural gas is not currently subject to any production quota or ceiling by OPEC (Igbikiowubu, 2006).

Although efforts have been made by the government to establish more infrastructures to increase gas output to 30 million metric tons per year, such efforts are yet to yield tangible results. This paper is approached from the infrastructure development perspective, given that the quantity and quality of a commodity is improved where there is adequate infrastructure for production, storage and distribution (Stoner, 2013). Since Nigeria relies more on oil earnings, and is threatened by the vagaries of the oil market (international politics inclusive), liquefied natural gas currently tends to have become a complementary product which can attract further investment for profitable yields if adequate infrastructure is laid for that purpose. The paper is organized in what follows. Section 2 establishes a conceptual framework; section 3 appraises the Nigerian gas sub-sector by situational case. Finally, section 4 concludes and provides recommendations with suggestions for further investigation into the sub-sector.

Literature and Conceptual Framework

That infrastructure is indispensable to economic development and growth is fast becoming a classical view. Indeed, sustainable economic development is hinged on the continued availability of a stock of infrastructure (Byoungki, 2006). Within the context of this paper, infrastructure is exemplified by two major components which are economic and social (Turan, 2011). However, economic infrastructure is further sub-categorized into public utilities, public works and transportation.

Table 1: Economic Infrastructure

Public Utilities	Public Works	Transportation
Power, telecommunications, water supply, sanitation, sewage, solid waste collection, postal services	Paved roads, dams, canals, drainage system, airports, seaports, railway, bridges, communication facilities	Urban road transportation, waterways, air transport

Source: Bameke, 2012

Bameke combines and highlights the features of each of the three sub-categories of economic infrastructure as shown in table 1. In essence, economic infrastructure is the totality of the system of public utilities, physical public property (public works) and transport services (transportation). On the other hand, social infrastructure consists mainly of education and health services (Turan, 2011; Yusuf, 2007). Irrespective of the categorization, it is inferred that infrastructure is the capacity of available service system to meet the present needs of the population. Every sector of the national economy relies on efficient, and adequate operational facilities to provide services that meet production targets as well as individuals' needs. Such facilities with operational capacity utilization base largely define infrastructure (Musket, 2010). This conceptual definition is succinctly assumed in this paper.

One other concept that needs clarification for the purpose of this paper is *development*. The concept is multi-dimensional. But considering the focus of this paper on a significant featureof Nigeria's economy, the gas sub-sector, Schumpeter's concept of development (cited in Akintoye and Awosika, 2000) is assumed. Accordingly, development is a discontinuous and spontaneous change in the stationary state which tends to alter and displace the existing equilibrium state while growth is a gradual and steady change in the long run. Development therefore is about evolving a new state of affairs which should leave, in economic terms, a positive impact on both the people and the national economy (Kraus, 2014; Slanikov, 2012). Nevertheless, attention should shift to 'sustainable development' because situations do occur in both the economy and environment that hamper the existing status of development. Consequently, governments, economic policy makers, development economists and researchers shift focus to sustainable development.

In the light of this paper, it is appropriate to draw a concept of sustainable infrastructure development. In the first instance, according to Kundan (cited in Akintoye and Awosika, 2000), sustainable development is a construct designed to meet 'the needs of the present generation without compromising the needs of the future generation.' Sustainable infrastructure development, by analogy, and located within Kundan's concept, will mean creating adequate capacities (technological + social + economic = infrastructure) to meet the needs of present population without compromising the needs of future generation and ensuring that the infrastructural capacity is updated to cater for the demands of the increasing populace of the future.

The key word in the phrase 'sustainable infrastructure development' is 'infrastructure' from which 'infrastructural' is formed. Independently, both 'sustainability' and 'development' are broad concepts. However, the inclusion of 'infrastructure' is an attempt to restrict their application and area of capture. The concept of sustainable infrastructural development embraces long-term continuous improvement in, and addition to the stock of facilities available for production purposes and for the satisfaction of human needs in the present and future, with an articulate policy for preserving the environment (*Rio Declaration on Environment and Development*, 1992;

Oladeji, 2014).

Sustainable development is pervasive but its strategic meaning can only be scientifically deduced when the concept is restricted to a specific area or modified as it is in 'sustainable infrastructural development.' There are, however, dominant development theories, but in relation to the issue of infrastructure (physical), the emerging theories, which incorporate more of environmental issues, appear more apt. These theories combine Solow's model neoclassical growth model and elements of the Harrod-Domar growth formulation (Oladeji, 2014). Furthermore, introduction of technology (as an independent variable) into the Solow's model is particularly notable, considering the importance of technology in the gas sub-sector of developing countries.
Various studies have evidently shown the substantial significant impact of infrastructure on growth and development (World Bank, 1994; World Bank, 2007). Other studies have also revealed the significance of infrastructure in economic development, further corroborating the significant impact of infrastructure investment on economic growth and development, particularly for developing countries (Byoungki, 2006; World Bank, 2011).

Nigerian Gas Sub-sector Outlook
Nigeria is the ninth producer of natural gas in the world. It is, however, the largest producer in Africa. In 2013, Nigeria's natural gas reserves were estimated to be 182 trillion cubic feet (Olanrewaju, 2014). In 2012, the country produced about 1.2 trillion cubic feet of natural gas. Majority of Nigeria's natural gas reserves are located in the Niger Delta region. Table 2 highlights gas projects already embarked upon by the government.

Table 2: Gas Projects by the Nigerian Government

1.	Escravos Gas-to- Liquids Plant
2.	Brass LNG
3.	Escravos Gas Plant Development
4.	Sonam Field Development
5.	Onshore Asset Gas Management Project
6.	Assa-North/Ohaji South Development
7.	Idu Project
8.	Tuomo Gas Field

Source: Nigerian Oil and Gas Review (2014)

The Nigerian government's initiatives in the gas sub-sector are categorized as solo and collaborative. Tables 2 and 3 describe government's initiatives. Table 2 is a highlight of government's solo initiative while Table 3 is a highlight of government's collaborative initiative with some oil companies in the private sector. Table 2 reveals the Nigerian government's efforts at investing in the development of the gas sub-sector. A gas master plan was developed in 2008 for the promotion of investment in pipeline infrastructure and new gas-fired power plants with the aim of reducing gas flaring and improving the generation of electricity (Olanrewaju, 2014). Financial investment in the gas sub-sector is huge thus requiring the entry of international investors and, to a large extent, collaboration between local and foreign organizations. However, security risks in the Niger Delta constitute threats to the entry of foreign oil and gas companies thus making it difficult and discouraging them from investing in the construction of modern infrastructure in the gas sub-sector.

Table 3: Gas Projects by Collaboration

1.	Nigerian Liquefied Natural Gas Project
2.	Nigerian Gas Company
3.	Mobil's Oso Natural Gas Liquids Recovery Project
	Shell Nigeria Gas Limited
4.	Chevron's Escravos Gas Project
5.	Nigeria Agip Oil Company Gas Recycling Project
6.	ELF Petroleum Nigeria Limited
7.	West African Gas Pipeline Project
8.	

Source: *Nigerian Oil and Gas Review (2014)*
Nigeria's Oil and Gas Annual. Various editions

In relation to the Nigerian gas sub-sector, according to Omotowa (Olanrewaju, 2014):
Nigeria can generate all the revenue it requires, if necessary infrastructure is put in place and adequate attention is given to gas exploration… we still have a lot of infrastructure that we have not put in place. I am talking about installation of new gas-gathering facilities, roads, power, transportation facilities and more. We still need a lot of money to develop all these facilities… once we develop infrastructure and other industries, then they would be able to contribute more to the revenue of the country and we should still be able to do well as a country with, or without oil.

Every sector of the economy provides opportunities for growth with the participation of investors. Similarly, the gas sub-sector is laden with the potential to generate employment, increase national power output and as a source of additional revenue. Currently, the Nigerian Liquefied Natural Gas Project delivers about 7 per cent of global supply of natural gas (*Nigerian Oil and Gas Review, 2014*).

There is a significant correlation between the performance of the gas sub-sector and that of the power sub-sector in Nigeria (Etukudo, 2015). There is abundance of gas in Nigeria which is sufficient to generate enough electricity for the country. To the contrary, there is no adequate infrastructure to ensure speedy and uninterrupted supply of gas to power plants (Ajibade, 2014). The cumulative effect of this problem on the operation of the power sub-sector which relies on gas is the dismal performance of the sub-sector. Gas-powered plants require huge volumes of gas for the generation of electricity. The Nigerian power sub-sector is 80 per cent turbine-reliant and 20 per cent hydro-reliant. It is evident then that the power plants in Nigeria need uninterrupted supply of gas to guarantee regular supply of electricity.

Power generating firms in Nigeria require millions of metric tons of gas per day to produce electricity as well as reach the optimal capacity level. About 200,635 cubic feet of gas per day are required to generate 1,000 megawatts (Fatona, cited in Ajibade, 2014). The power, oil and gas sub-sectors are complementary and supportive of one another for economic growth and development. Failure to develop any of the sub-sectors has negative implications for the entire energy sector. Developed economies, comparatively Germany, the United States, Britain, Japan and Canada among others rely on efficient and effective functioning of the power sub-sector.

Liquefied Natural Gas Demand Projection
Efforts by governments to promote the consumption of gas as part of the initiative to discourage environmental degradation in Nigeria have resulted in a number of gas projects. Nevertheless, increasing potential demand for natural gas suggests that countries with excess deposits of natural gas develop the infrastructure, technological process and human resources to exploit the gains

from the availability, sale and use of gas. There are global projections by *BP Energy Outlook* that natural gas demand would grow by 1.9 per cent yearly up to about 490 billion cubic feet by the year 2035 (Okere, 2015).

Currently, China, Japan, Australia and Europe rank as great markets for the demand and consumption of liquefied natural gas (Oben, 2015). Europe'sshare of liquefied natural gas imports has risen from 16 per cent to 19 per cent since 2013 (Biduo, 2014). Nonetheless, the ability of gas producing countries to respond to rising demands across the continents implies that regions where gas supply (imports) is deficit would invariably attract large gas supplies by paying a marginal premium over the going market rate. This is perceived motivation for gas producers to facilitate storage and respond to demand for gas. For as long as the market for gas is readily available, extra foreign exchange vertical integration and market structure in the gas sub-sector. The market structure is characterized by the degree to which regulatory authorities control the market influence of the existing gas companies (Conway and Nicoletti, 2006).

Conclusion and Recommendations

A strong energy sector (inclusive of oil and gas sub-sectors inevitably provides the engine room for industrialization, economic growth and development, but it is with the installation of the requisite infrastructure. Balanced economic growth is realizable through increased commitment to gas development and the creation of investment-friendly environment. The Nigerian Liquefied Natural Gas Project exhibits great prospects for revenue generation for the economy. However, intrigues of international politics which could sideline any developing oil producing country suggest that a new stream of national earnings should be explored. Exploitation of natural gas and utilization of associated gas for domestic and industrial purposes are identified as significant steps in the quest for rational use of energy and as an alternative source of national income.

The efficiency and productivity of the gas sub-sector are hinged on government's political will to promote the sector through collaborative investment. However, it is recommended that a legal framework and a well-articulated gas sub-sector policy should be formulated to define entry and participation, role, rules and regulations for all stakeholders. Consequently, there is need to have an operational petroleum industry bill for the Nigerian gas sub-sector.

It is ideal to establish a separate commission to be responsible for the regulation of the gas sub-sector in Nigeria. Such a commission should be empowered statutorily to monitor the sub-sector, attract investors and ensure that investing shareholders have access to equity and fairness. Indeed, further liberalization of the gas market in Nigeria should be a national objective.

Generally, creating awareness of the commercial quantity, benefits and industrial use of gas in the Nigerian society should be some motivation that attracts patronage. However, investment in infrastructure in the gas sub-sector remains a priority.

A limitation in the methodology of this study is the non-inclusion and analysis of revenue generated and investment in the gas sub-sector over a specified period of time. Further research in the Nigerian gas sub-sector could be conducted, integrating panel data and the technology process as a variable. Furthermore, indigenous manpower is a requirement in the gas sub-sector as much reliance on foreign manpower (foreign experts) has implications for capital flight out of the Nigerian economy.

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