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Invited review

A review of the utilization and monetization of Nigeria's natural gas resources: Current realities

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ABSTRACT

Natural gas is destined to become a larger part of Nigerian energy mix as the country seeks to guarantee the sustainability of its energy supply and benefit from greater energy efficiency and reduce energy-related costs. However, this continues to be a relatively slow process with large quantities of associated gas still being flared, as it has been since the 1950s. Natural gas' availability, versatility, accessibility, and more importantly its clean-burning characteristics when compared to other fossil fuels, is a substantial driver for its further utilisation in country. Nigeria is endowed with some 182 trillion cubic feet (tcf) of proven gas reserves, and that is mostly located in the Niger Delta. Nigeria's government is keen to develop local utilization of gas employing a range of available technologies. These technologies include gas to power using gas fed by transmission and distribution pipeline networks to supply combined cycle gas turbines (CCGT), compressed natural gas (CNG), gas to liquids (GTL) to supply transportation fuels, gas to fertilizer (GTF) and petrochemicals to support domestic industries, and export options involving liquefied natural gas (LNG), the West African Gas Pipeline (WAGP), and, in the future, other potentially large-scale export routes (e.g. to Europe through a Trans Saharan Gas Pipeline (TSGP). This paper reviews these gas utilization options, export potential, and government's policies that are stimulating gas investments in Nigeria.

1. Introduction

According to BP's Energy Outlook 2035 (2014), global energy consumption will grow by 41% by 2035, and 95% of this growth will come from the fast emerging economies. Nigeria is at the centre of this growth in energy demand, which cannot be met by available oil resources alone. Its abundant natural gas resources need to be more fully utilized to meet this rapidly increasing demand for energy, both domestically and in the developing world more generally.

Nigeria's population was some 169 million people at the end of 2012 having grown from 45.2 million in 1960. It's Africa's most populous country, and one fifth of the sub-Saharan African population. By 2030 Nigeria's population is likely to exceed 200 million.

The role of natural gas in the global energy market seems likely to also grow contributed by the sharp rise in proven conventional and unconventional gas reserves worldwide, and the greater importance and priority given by the major energy importing countries to security and diversification of supply (Nwaoha and Iyoke, 2013).

Natural gas transportation and storage is more complex than that of oil, and this contributed to its slow utilisation for a considerable period, Nigeria in particular. The global gas market has changed in the last couple of decades and it is currently experiencing rapid market expansion compared to other fossil fuels (Economides and Wood, 2009). Currently, natural gas is the third largest global energy source (Fig. 1) and its consumption is expected to increase substantially in coming decades. Investment in natural gas continues to grow due to its availability, versatility and because it is a cleaner energy source compared to coal and crude oil (Leather et al., 2013).

Because natural gas is the cleanest burning hydrocarbon and also has a high energy conversion efficiency when used for power generation in combined cycle gas turbines, Economides and Wood (2009), forecasted that the natural gas sector would continue to

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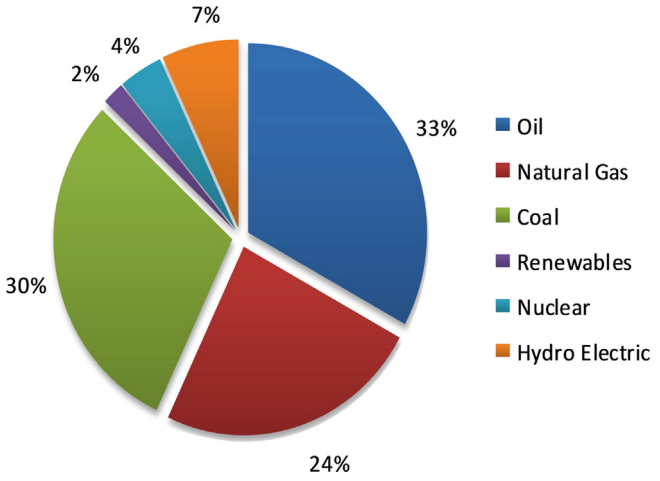

Fig. 1. Global energy consumption by fuel at the end of 2012 (Source: BP Statistical Review of World Energy, June 2013).

experience significant growth over coming decades. Indeed others believe that gas may even overtake oil as the prime fuel between 2020 and 2030. Whereas, in much of the world the main competition for gas in recent years has been cheap coal for power generation, particularly in China, India, OECD Asia and Europe, in Nigeria gas competes mainly with petroleum products derived from crude oil. Because oil is such a valuable source of export revenue it makes commercial sense for gas to displace petroleum products consumed domestically in Nigeria, thereby increasing the volumes of oil and petroleum products available for export.

From the BP Statistical Review of World Energy (2013), consumption of natural gas grew globally by 2.2% while that of natural gas production grew by 1.9%. USA (+4.7%) continues to record the largest volumetric increase and have also remained the world's largest producer. In addition, Norway (+12.6%), Qatar (+7.8%), and Saudi Arabia (+11.1%) all experienced significant increases in gas production, while Russia (−2.7%) had the world's largest decline in volumetric terms.

Within this global context, here we focus upon the resources and utilization of natural gas in Nigeria.

2. Nigeria's conventional natural gas resources in a global view

According to BP Statistical Review of World Energy (2013), Nigeria's current proven natural gas reserves stood at approximately 182 trillion cubic feet (tcf), making the country's gas reserves the ninth largest in the world (Table 1), and hold about 2.8% of total global reserves. However, the Nigeria LNG' Facts and Figures (2013), believe that if companies deliberately explore for gas (as opposed to finding it while in search of oil) Nigeria have the potential to discover up to 600 TCF. Considering this, Nigeria can rise into the top four natural gas resource holders in the world.

Of importance and particular interest is the high quality of Nigeria's gas, virtually without sulphur, low in carbon dioxide (CO_2), and rich in natural gas liquids (NGL) including abundant condensate (C_{5+}) (Odumugbo, 2010). Nevertheless, on a more troublesome note, Nigeria remains among the top few gas-flaring countries, accounting for some 16% of global gas flared (US Energy Information Administration, 2013). According to the Society of Petroleum Engineers (SPE, 2012), Nigeria flares about 1.3 TCF of natural gas annually. The lack of gas utilization infrastructure in Nigeria has resulted in flaring of about 75% of the associated gas

Table 1
Proved Natural gas reserves as at end of 2012.

	Proved reserves	At end 2012			
	Total world	6614.1	187.3	100.0%	55.7
	Country	Trillion cubic feet	Trillion cubic meters	Share of total	R/P ratio
1	Iran	1187.3	33.6	18.0%	>100
2	Russian Federation	1162.5	32.9	17.6%	55.6
3	Qatar	885.1	25.1	13.4%	>100
4	Turkmenistan	618.1	17.5	9.3%	>100
5	USA	300.0	8.5	4.5%	12.5
6	Saudi Arabia	290.8	8.2	4.4%	80.1
7	United Arab Emirates	215.1	6.1	3.3%	>100
8	Venezuela	196.4	5.6	3.0%	>100
9	**Nigeria**	**182.0**	**5.2**	**2.8%**	**>100**
10	Algeria	159.1	4.5	2.4%	55.3
11	Australia	132.8	3.8	2.0%	76.6
12	Iraq	126.7	3.6	1.9%	>100
13	China	109.3	3.1	1.7%	28.9
14	Indonesia	103.3	2.9	1.6%	41.2
15	Norway	73.8	2.1	1.1%	18.2
16	Egypt	72.0	2.0	1.1%	33.5
17	Canada	70.0	2.0	1.1%	12.7
18	Kuwait	63.0	1.8	1.0%	>100
19	Libya	54.6	1.5	0.8%	>100
20	India	47.0	1.3	0.7%	33.1
21	Malaysia	46.8	1.3	0.7%	20.3
22	Kazakhstan	45.7	1.3	0.7%	65.6
23	Uzbekistan	39.7	1.1	0.6%	19.7
24	Netherlands	36.7	1.0	0.6%	16.3
25	Oman	33.5	0.9	0.5%	32.8
	Sum of top 25 Countries	6251.3	176.9	94.8%	
	Rest of the World	362.8	10.4	5.2%	

Source: BP Statistical Review of World Energy June 2013.

with just 12% of produced gas re-injected back into sub-surface reservoirs (Ahmed et al., 2012).

Majority of Nigeria's proven gas reserves are situated in the Niger Delta region of the country which covers an area of about 41,000 sq. miles (106,189.50 km^2). 70% of Nigeria's proven gas reserves are located on land, while offshore accounts for 30% (Igwe, 2011). About 60% of these reserves are located east of the River Niger, the remainder to the west of that river. The total conventional natural gas resources located within Nigeria are certainly enough to last several hundred years, with the potential to fuel Nigeria's industries, homes, and international export for the foreseeable future.

About 40% of Nigeria's total proven gas reserves are classified as stranded gas caps, and they are available for exploitation (Yar'adua, 2007). In addition, non-associated gas (NAG) constitutes key deposits, some of which are being exploited now. In order to promote increased utilisation these vast gas resources, the federal government of Nigeria proposed the Nigerian gas master plan (NGMP), which was directly aimed at assuring long-term gas security through managed resource exploitation (Odumugbo, 2010). The NGMP targets the challenge of achieving gas-driven economic growth with strong focus on gas to power projects. A key contentious issue in securing investment for such developments in recent years has been the low price that successive governments have been prepared to pay suppliers for feed gas supply.

Fig. 2 indicates recently approved ceiling prices paid for feed gas by the power sector in Nigeria. However, irrespective of the approved ceiling gas prices shown in Fig. 2 (i.e., the maximum prices paid to gas suppliers for each year shown), the actual average price paid for gas in 2011 and 2012 (by the power sector) was $0.3/mmBtu and $1.0/mmBtu, respectively (Ige, 2013b, p.21; Ige, 2013a, p.7). Such low prices were aimed at encouraging further