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The Effect Of Natural Gas Production And Flaring On The Economy Of Nigeria

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Abstract: ***Nigeria is blessed with massive reserves of associated and non-associated gas, estimated in excess of 160 trillion cubic feet. It is ranked amongst the 10th largest in terms of proven natural gas reserves in the world, and its natural gas reserves and production is estimated at 109 years. But for years, Nigeria has remained one of the biggest gas flarers, in spite of the associated environmental hazards of gas flaring. The government is, however, working to achieve a target of zero flares in the near future. The objective of this paper is paper to outline the usefulness and challenges with production of natural gas in Nigeria. In addition, natural gas can be used for power generation and domestic industries (such as fertilizers, steel, etc.) The advantages and limitations of each option with respect to engineering, economic, supply/demand, market and political issues are discussed. Recommendations are presented to show how this resource can be effectively utilized in promoting Nigerian economic and industrial development in the years ahead.***

Keywords: Gas Flare, Natural Gas, Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG).

I. INTRODUCTION

Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane, with up to 20 percent concentration of other hydrocarbons as well as impurities in varying amounts such as carbon dioxide. Natural gas is found in deep underground natural rock formations or associated with other hydrocarbon reservoirs, in coal beds, and as methane clathrates. Most natural gas was created over time by two mechanisms: biogenic and thermogenic. Biogenic gas is created by methanogenic organisms in marshes, bogs, landfills, and shallow sediments. Deeper in the earth, at greater temperature and pressure, thermogenic gas is created from buried organic material. Historically, the energy industry is being fueled by crude oil and natural gas exploration and development. The use of associated gas will provide environmental improvements by reducing flaring which contributes to global warming.

Natural gas, as it is used by consumers, is much different from the natural gas that is brought from underground up to the wellhead. Although the processing of natural gas is in many respects less complicated than the processing and refining of crude oil, it is equally as necessary before its use by end users (Kennedy, 1993). Raw natural gas comes from three types of wells, oil wells, gas wells and condensate wells. Natural gas that comes from oil well is typically termed "associated gas". Natural gas from gas and condensate wells, in which there is little or no crude oil, is termed 'non-associated gas. Gas wells typically produce raw material natural gas by itself, while condensate wells produce natural gas along with a semi-liquid hydrocarbon condensate.

Natural gas utilisation is a primary goal of Nigeria's petroleum and energy policies. This is because, with a proven reserve of excess of 160 trillion cubic feet of natural gas, Nigeria's gas reserve is triple the nation's crude oil resources. By not fully harnessing its gas resources, associated gas encountered during the normal course of oil production has been largely flared. Nigeria is reputed to be the largest gas-flaring country in the world.

Due to the awareness of the importance of natural gas as a source of energy, more gas fields are discovered and the current proved world reserve of natural gas is on the increase. Instances have been given about gas being the next dominant world. It also plays a major role as a back-up energy

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resource, especially in the rapidly increasing sector of power plants, and as a feed stock in the fast growing sector of petrochemicals. This indicates that consumption of domestic gas, hitherto flared, will play a larger role in Nigeria's economic development. Natural gas is one of the most important sources of energy today because it is environmentally friendly and has economic and technical advantages.

II. USES OF NATURAL GAS

Natural gas is widely used and is an important energy source in many applications including heating buildings, generating electricity, providing heat and power to industry and vehicles and is also a feedstock in the manufacture of products such as fertilizers. The use of natural gas in the recent time has tremendously increased due to its proven importance as a source of clean energy compared to other consumable energy resources. In most developed western countries, natural gas is widely used at the present time not only as fuel but also as feed stock, compacting with oil for producing commodities such as plastics, rubbers, medicine, and fertilizers to mention a few. Natural gas is now being widely recognized as the premium fuel, both for home healing and for other purposes. It is convenient to use, clean burning, and reasonable in cost. Natural gas is also used in the manufacture of fabrics, glass, steel, plastics, paint, and other products. Major uses of natural gas are explained as follows:

- ✓ Transportation - CNG is a cleaner alternative to other automobile fuels such as petrol and diesel. The energy efficiency is generally equal to that of petrol engines, but lower compared with modern diesel engines. Petrol vehicles converted to run on natural gas suffer because of the low compression ratio of their engines, resulting in a cropping of delivered power while running on natural gas (10%–15%). CNG-specific engines, however, use a higher compression ratio due to this fuel's higher octane number of 120–130.
- ✓ Aircraft fuel - An aircraft manufacturer (Tupolev in Russia) is running a development program to produce LNG- and hydrogen-powered aircraft. The programme claims that an LNG-powered aircraft would cost less to operate per ton, roughly equivalent to 60%, with considerable reductions to carbon monoxide, hydrocarbon and nitrogen oxide emissions. The advantages of liquid methane as a jet engine fuel are that it has more specific energy than the standard kerosene mixes do and that its low temperature can help cool the air which the engine compresses for greater volumetric efficiency, in effect replacing an intercooler. Alternatively, it can be used to lower the temperature of the exhaust.
- ✓ Heating/Cooking Purposes - Natural gas dispensed from a simple stovetop can generate heat in excess of 2000°F (1093°C) making it a powerful domestic cooking and heating fuel. In much of the developed world it is supplied to homes via pipes where it is used for many purposes including natural gas-powered ranges and ovens, natural gas-heated clothes dryers, heating/cooling, and central heating. Home or other building heating may include boilers, furnaces, and water heaters. Compressed natural gas (CNG) is used in rural homes without connections to piped-in public utility services, or with portable grills. However, due to CNG being less economical than LPG, LPG (propane) is the dominant source of rural gas.
- ✓ Agricultural purposes - Natural gas is a major feedstock for the production of ammonia, via the Haber process, for use in fertilizer production.
- ✓ Hydrogen production - Natural gas can be used to produce hydrogen, with one common method being the hydrogen reformer.

III. NATURAL GAS PRODUCTION

Natural gas undergoes processing to strip clean the gas and remove impurities before it can be used. Natural gas is currently produced in Nigeria, mostly in the form of associated gas. The choice to use this produced gas was not encouraged as a result of high production costs, inadequate technology, unavailability of local consumers and prospective markets being too far away from the source country. The second choice was to flare the produced gas. The latter was chosen. The by-products of processing include ethane, propane, butanes, pentanes, and higher molecular weight hydrocarbons, water vapor, hydrogen sulphide, carbon dioxide, and sometimes some inert gases.

IV. FLARING

Gas flaring rose from 94 percent in the late 1960's to 99 percent in the early 1970's (Idiodi, 1985). Gas flaring fell gradually to 87 percent of produced gas as its use for generating power, gas lifting and reservoir pressure maintenance was increased. In 1990, gas production totaled 1003.9 BSCF, of which 971.5 BSCF or 79 percent was flared. While Nigeria realized the wasting of this natural resource by flaring, it was not until the mid 1980's that "serious" considerations were given to the effective utilization of natural gas, currently second to crude oil, in anticipated revenue earnings.

A gas reserve in Nigeria has been accidentally discovered while exploring for oil. Until 1965, 67.8 percent of all the wells drilled off the Niger Delta were oil wells. In about 25 years (up to the end of 1984) the Niger Delta province yielded more that 11.2 billion barrels of oil, and 6.9 trillion cubic feet of associated gas (Agbon, 1987). Systematic undiscovered natural gas reserve estimates have not recently been officially published. Conservative estimates of recoverable proved reserves stand at about 41 trillion cubic feet of gas (Chukwu and Chukwu, 1993). Nigeria has the largest gas reserves on the continent of Africa (A position formally occupied by Algeria) as it appears as the only African country in the top 18 natural gas reserves nations in the world as can be seen in Table 1. The securing of energy during the next decade is diverted towards the increasing consumption of gas. Future planning through the expansion of gas reservoirs and gas

supply networks, the supply of gas for the gas injection projects to maintain adequate reservoir pressures in the oil reservoirs, and developing ways and means to enter the international gas export markets in the next four to five years should be Nigeria's ultimate goal and priority.

Rank	Country/Region	Natural gas proven reserves (m^3)	% of total
Total	World	300,000,000,000,000	100%
1	Russia	55,000,000,000,000	18.3%
2	Iran	33,500,000,000,000	11.1%
3	Turkmenistan	26,200,000,000,000	8.73%
4	Qatar	25,470,000,000,000	8.5%
5	United States	9,000,000,000,000	3.0%
6	Saudi Arabia	8,200,000,000,000	2.73%
7	UAE	6,100,000,000,000	2.03%
7	Azerbaijan	6,071,000,000,000	2.02%
8	Venezuela	5,524,500,000,000	1.84%
9	**Nigeria**	**5,246,000,000,000**	**1.75%**
12	Iraq	3,600,000,000,000	1.17%
13	China	3,100,000,000,000	1.02%
14	Indonesia	3,001,000,000,000	1.58%
15	Kazakhstan	2,407,000,000,000	1.27%
16	Malaysia	2,350,000,000,000	1.24%
17	Norway	2,313,000,000,000	1.22%
18	European Union	2,250,000,000,000	1.18%

Table 1: Natural gas reserves for top 18 nations (The World Factbook Based on data from BP, 2010)

V. UTILIZATION AND INDUSTRIAL DEVELOPMENT

Natural gas is a vital source of revenue for many producers around the world who have developed the technology, to cost effectively produce, transport, and develop the marketing network to sell this commodity. It is exported in its natural form by land through pipelines or in liquid form by sea with LNG carriers. In Nigeria, the natural resources are underdeveloped and underutilized (Ebneyousef and Bogart, 1993) and unfortunately still remain so till today. Associated gas is still mostly flared. With the limited national funding for pipeline infrastructure and regional market development, it will take considerable time before the waste of this natural resource ends. An effective utilization of this commodity in commercial terms will not only increase Nigeria's foreign exchange earning power, but will also help to diversify her oil industry, while at the same time contributing to the conservation of her crude oil reserves.

In today's environment, the targets for local use of natural gas should include at least the following items:

A. LIQUEFIED NATURAL GAS (LNG)

While dry natural gas has found wide application in the industrial sector of the economy, Liquefied Natural Gas (LNG) has its wide application both domestically and industrially. Hence, the establishment of an LNG plant was a premier consideration in the effective utilization of natural gas resources. The successive earlier efforts prior to 1985 made by the Nigerian government for the establishment of the much talked about LNG plant have been well documented by Asiodu (1993).

Nigeria LNG Limited was incorporated as a limited liability company on 17 May 1989, to produce LNG and natural gas liquids (NGL) for export. The plant was built by TSKJ consortium, which was led by former Halliburton's subsidiary KBR. Other participants of the consortium were Snamprogetti, Technip and JGC Corporation. The first train came into operation in 1999. Nigeria LNG Limited is jointly owned in the following proportions: Nigerian National Petroleum Corporation (NNPC) owns 49%, Shell Gas B.V. owns 25.6%, Total LNG Nigeria Ltd owns 15% and Eni International owns 10.4%. The LNG Limited operates six liquefaction units (LNG trains) producing 22 million metric tonnes of LNG per year (MMTPA). This amounts to roughly 10% of the world's LNG consumption. Trains 1, 2 and 3 have production capacities of 3.2 MMTPA, whilst trains 4, 5 and 6 have capacities of 4.1 MMTPA each. The final investment decision on the train 7 has not yet been made.

Nigeria, through NNPC, also entered into a joint venture with Chevron for the establishment of a gas utilization project. The project involved the installation of gas-gathering and extraction facilities on the coast of Escravos. At maximum capacity it can produce more than 170 million cubic meters of gas per day from Chevron's Okan and Mefa fields. It also produces 130 million cubic meters of gas per day of dry residue gas for sale to the Nigerian Gas Company which will bottle some for commercial and domestic consumers. With the above worrisome situation, the Nigerian Association of Petroleum Explorationists, NAPE deemed it fit to tag its 2012 Pre-Conference Workshop, "The Economic Imperative for the Local Utilisation of Nigeria's Gas Resources." (11^{th} – 15^{th} Nov, 2012).

B. GAS RE-INJECTION

Gas can be injected back into the formation to build-up enough energy for lifting oil from the ground. Also, in low pressure oil wells, associated gas can be used for gas-lifting wells where the primary energy is insufficient to drive the oil to the surface. Gas can be injected back into the formation to buildup enough energy for lifting oil from the ground. Also, in low pressure oil wells, associated gas can be used for gas-lifting wells what the primary energy is insufficient to drive the oil to the surface. (The Magazine of BP Exploration Worldwide, 1993)

C. POWER GENERATION

Natural gas is used to generate electricity and heat for desalination. Similarly, some landfills that also discharge methane gases have been set up to capture the methane and generate electricity. Natural gas can be a major source of electricity generation through the use of gas turbines and steam turbines. Most grid peaking power plants and some off-grid engine-generators use natural gas. Particularly high

efficiencies can be achieved through combining gas turbines with a steam turbine in combined cycle mode. Natural gas burns more cleanly than other hydrocarbon fuels, such as oil and coal, and produces less carbon dioxide per unit of energy released. For an equivalent amount of heat, burning natural gas produces about 30% less carbon dioxide than burning petroleum and about 45% less than burning coal. Combined cycle power generation using natural gas is thus the cleanest source of power available using hydrocarbon fuels and this technology is widely used wherever gas can be obtained at a reasonable cost. Fuel cell technology may eventually provide cleaner options for converting natural gas into electricity, but as yet it is not price-competitive. Natural gas is one of the most efficient and one of the cleanest ways of generating electricity. When compared to coal or oil, its environmental credentials are sound. It emits less of the acid gases – So_x and NO_x – than do coal or oil. It produces less of the greenhouse gas carbon dioxide and it is almost dust and ash free.

VI. NATURAL GAS ENVIRONMENTAL POLLUTION ASSESSMENT

Cleaning up pollutants can take as much money from a company as the profit it actually makes. It is like taking two steps forward and sometimes two steps back on the progress road map. Natural gas is often described as the cleanest fossil fuel, producing less carbon dioxide per joule delivered than either coal or oil and far fewer pollutants than other hydrocarbon fuels. However, in absolute terms, it does contribute substantially to global carbon emissions, and this contribution is projected to grow. According to the IPCC Fourth Assessment Report, 2004, natural gas produced about 5.3 billion tons a year of CO_2 emissions, while coal and oil produced 10.6 and 10.2 billion tons respectively. According to an updated version of the report, 2012, by the year 2030, natural gas would be the source of 11 billion tons a year, with coal and oil now 8.4 and 17.2 billion respectively because demand is increasing 1.9% a year.

In addition, natural gas itself is a greenhouse gas more potent than carbon dioxide. Although natural gas is released into the atmosphere in much smaller quantities, methane is oxidized in the atmosphere, and hence natural gas affects the atmosphere for approximately 12 years, compared to CO_2, which is already oxidized, and has effect for 100 to 500 years. Natural gas is composed mainly of methane, which has a radiative forcing twenty times greater than carbon dioxide. Based on such composition, a ton of methane in the atmosphere traps as much radiation as 20 tons of carbon dioxide; however, it remains in the atmosphere for 8–40 times less time. Carbon dioxide still receives the lion's share of attention concerning greenhouse gases because it is released in much larger amounts. Still, it is inevitable when natural gas is used on a large scale that some of it will leak into the atmosphere.

VII. CONCLUSION

Development of research Institutes and support for research projects through University research centers should be encouraged. Documenting successful results of laboratory research on certain chemicals as well as some special products which at present are draining the foreign earnings of the oil and other industries, can lead to local production of these products on an industrial scale

Expansion of Gas industry depends on speeding up exploration activity for gas reserves. Suitable acreage should be identified and the terms offered for exploration should be attractive enough to draw in reputable and dependable investors. The utilization of gas for commercial and domestic purposes has a lot of advantages over other sources of energy. While it is not feasible to satisfy all the needs of the Nigerian economy by utilizing only gas energy, it is economically advantageous to utilize its significant contribution to energy saving in the domestic, commercial and industrial sectors. Since natural gas is an exhaustible asset its use should, like that of oil, be tampered by the thought of future scarcity.

REFERENCES

[1] Agbon, S. (1987). "*Energy Utilization Policies and Nigerian Economic Development in the 199Os*" in: Proceedings of Society of Petroleum Engineers Tenth Annual International and Exhibition, Lagos, Nigeria.
[2] Asiodu, P. (1993). "*Nigerian LNG Project to use Air Products Liquefaction System'*. OPEC Bulletin. Vol. XXIV. No.6. pg. 17
[3] Chukwu, G.A., and. Chukwu F.I (1993). Essential Raw Materials for the Future: Challenges and Strategies for Their Effective Utilization", in Proceedings of the First Africa-U.S.A. International Conference on Manufacturing Technology. Lagos, Nigeria.
[4] Ebneyousef, M.H and Bogart A.J. (1993). 'Natural Gas and the Newly Evolving OPEC, SPE Paper No.26409, presented at the 68th Annual Technical Conference and Exhibition of the Society of Petroleum Engineers. Houston, Texas.
[5] Idiodi, N. O. (1985). "The Geopolitics and Impact of Natural Gas in the National Fuel-Energy Balance", SPE NS Paper No. 204, presented at the 9th Annual international Conference of the Society of Petroleum Engineers, Nigerian Section, Port Harcourt.
[6] IPCC Fourth Assessment Report (Working Group III Report, chapter 4). 2004
[7] Kennedy, J.L.(1993). "Oil and Gas Markets, Companies, and Technology in the 90's and Beyond', SPE Paper No. 26406, presented at the 68th Annual Technical Conference and Exhibition of the Society of Petroleum Engineers. Houston. Texas.
[8] Oil Industry Plans for 1993-97 (Part Two). (1993). Iran Oil News, Vol. 78, pp. 13-18. 1993
[9] Nigerian Gas Project Moves onto Drawing Board. (1993). OPEC Bulletin. Vol. XXW, No, 3, p. 17.
[10] Nigerian Association of Petroleum Explorationists, NAPE. (2012). "*The Economic Imperative for the Local*

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Utilisation of Nigeria's Gas Resources." Pre-Conference Workshop.

[11] The Magazine of BP Exploration Worldwide (1993). No. 10, pp. 17-19.