

## Gas Resource Development in Nigeria and the Global LNG Market.

<sup>1</sup>Akintunde A. Carim, <sup>2</sup>Prof. Adewale Dosunmu

*Institute Of Engineering, Technology and Innovation Management (METI) /*

*Department Of Petroleum and Gas Engineering, University Of Port Harcourt, Rivers State, Nigeria.*

---

### ABSTRACT

*The aim of this research is to review the gas resource development in Nigeria and the contribution to global LNG and export markets. To engage in global LNG business, energy companies invest in the LNG value chain which involve different operations that are linked and dependent on one another. The evolution of global and regional LNG trade over the past twenty five years has been a story of rapid growth and diversification. The only major investment in gas development in Nigeria has been the LNG projects. The LNG brings stranded natural gas reserves to the global markets. Some of the gas that would otherwise be flared are converted to the LNG as Nigeria has consistently been second worst gas flaring country in the world after Russia (Oniwon, 2011).*

*The need to reduce flaring have contributed to increase interest in the LNG business as a means of utilizing valuable natural gas resources and contributing towards sustainable development.*

*Overall the paper provides useful information to decision makers responsible for managing gas export projects including the LNG in a developing Country like Nigeria with huge proven gas reserves.*

**Keywords-** *LNG projects, global and regional trade, gas flaring, Re-gasification, gas resources, gas export projects, Nigeria's Niger delta.*

---

Date of Submission: 19 March 2016



Date of Accepted: 05 April 2016

---

### I. Introduction

Natural gas is the cleanest-burning fossil fuel known to mankind and it is also becoming the energy source of choice worldwide. Nigeria is endowed with abundant natural gas reserves with current daily gas production of about 8.25 billion cubic feet per day (bcf/day) and less than half of the proven reserves have been committed to define projects (Osahon, 2014, Figs 1.1, 1.2). LNG is the liquid form of the natural gas people use in their homes for cooking and heating. LNG is also being used as an alternative transportation fuel in public transit and in vehicle fleets. LNG offers a global commodity which can be delivered reliably to meet the growth in demand for natural gas worldwide. The growth of the LNG industry has been facilitated by technology breakthroughs and market demand growth. The progressive increase in gas liquefaction train size with train sizes increasing steadily over the past few decades.

Nigeria has consistently been second worst gas flaring country after Russia, the country must take up the challenge and monetize the gas for the benefit of the country (Oniwon, 2011). These have contributed to increased interest in the LNG business as a means of utilizing valuable natural gas resources and contributing towards sustainable development. Over the past few years, many of the big oil and gas companies operating in Nigeria are involved in developing and operating LNG supply chains and look forward to take Final Investment Decisions (FID) on LNG projects. By 2014, Nigeria is the 4<sup>th</sup> largest exporters of LNG in the world (Table 1.1), closely following Australia, Malaysia and Qatar.

The only major investment in gas development in Nigeria has been the LNG projects. Some of the gas that would otherwise be flared are converted to the LNG.

The gas liquefaction, shipping and re-gasification are collectively classified as the Liquefied Natural Gas (LNG) value chain. The LNG is the natural gas that has been super cooled and converted to a liquid form and resulting in a cryogenic fluid via refrigeration at a temperature of minus 161 degree Centigrade (-161 deg C). Liquefied Natural gas is a clear, colourless, non-toxic liquid. It is then transported from a producing region to the consuming one by ship. Re-gasification involves conversion of the fluid to gas phase via vaporization for subsequent transportation through pipeline within the consuming region.

Majority of the LNG production come from the Asian Pacific region (table 1.1). The progressive buildup of Qatar capacity in the late 1990's allowed the Middle East to emerge as the largest exporting region. For almost

ten years in a row, Qatar remained the largest LNG exporter, providing to the market approximately one-third of the global supply (IGU, 2015). The world's five largest LNG importers are Japan, South Korea, China, India and Taiwan.

The Nigerian Liquefied Natural Gas Company limited (NLNG), a joint venture between the Federal government and foreign oil majors was set up to harness Nigeria's vast natural gas resources. The performance of this company is also benchmarked with the performance and management of the LNG projects in countries where gas resources have been better managed in terms of LNG usage, Qatar and Australia.

## TAB 1.1: LNG EXPORTS BY COUNTRIES, 2014

**TABLE 1.1: LNG EXPORTS BY COUNTRY, 2014**

Exporter	MT
Qatar	76.8
Malaysia	25.1
Australia	23.3
Nigeria	19.4
Indonesia	16
Trinidad	14.4
Algeria	12.8
Russia	10.6
Oman	7.9
Yemen	6.8
Brunei	6.2
UAE	5.8
Peru	4.3
Equatorial Guinea	3.7
Norway	3.6
Egypt	0.3
US	0.3
Angola	0.3

Sources: IHS, US DOE, IGU

**TABLE 1.2: LNG IMPORTS BY COUNTRY, 2014**

Importer	MT
Japan	88.9
South Korea	38
China	20
India	14.6
Taiwan	13.6
UK	8.5
Spain	8.2
Mexico	6.9
Brazil	5.7
Turkey	5.4
Argentina	4.7
France	4.7
Italy	3.3
Chile	2.8
Kuwait	2.7
Singapore	1.8
Malaysia	1.8
Others*	9.5

\*Belgium, Canada, Greece, Israel, the Netherlands, Portugal, Puerto Rico, Thailand, the UAE and the US.

Sources: IHS, US DOE, IGU

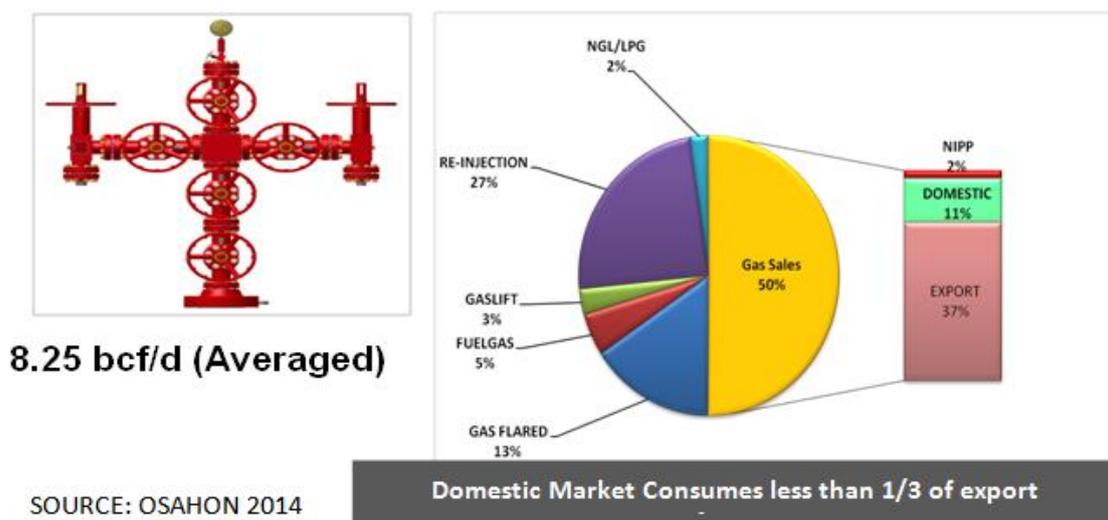
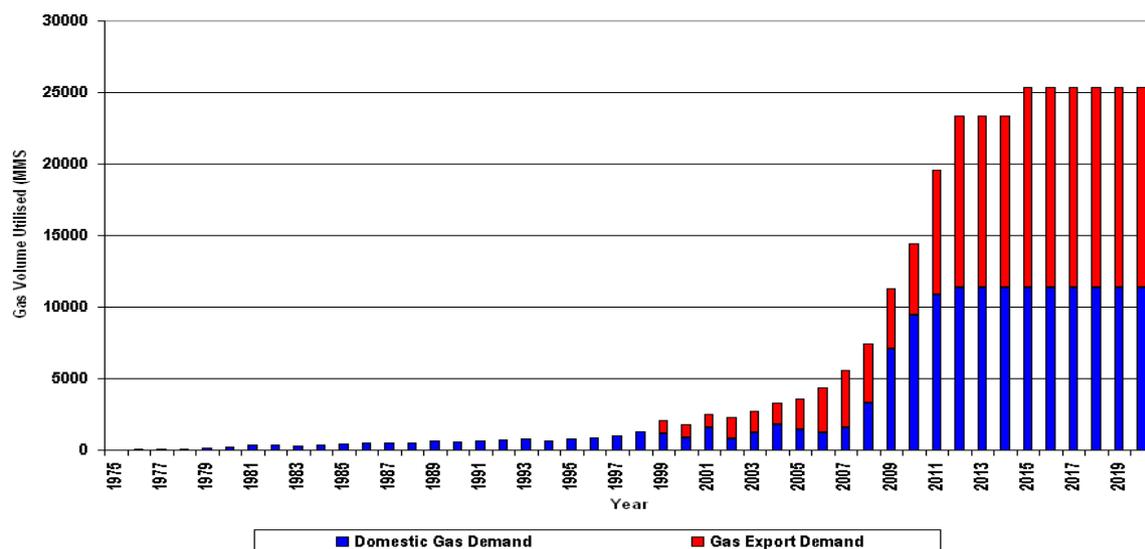


FIG.1. 1: NATURAL GAS PRODUCTION AND UTILISATION

Gas Demand Boom - Utilization Profile : 1975 - 2020



SOURCE: ONIWON, 2011

FIG 1.2: GAS UTILIZATION PROFILE (1975 – 2020)

There has been impressive growth in demand for gas in Nigeria. The demand is driven by a variety of sectors from power through to export LNG. The gas sector holds significant potential for Nigeria with robust reserve base and rapidly evolving demand base too. There is therefore the need to connect these reserves to market which is the key to realizing the economic potential of the gas reserves. Nigeria has the potential to increase gas utilization through gas exports and the LNG but delays in expansion of existing LNG plants is affecting the growth. LNG Projects are expected to provide a good return to investors but incentives are required because of high capital investment and long construction times necessitating projects requiring tax relief during the early years.

## 2.0 The Nigerian Liquefied Natural Gas (NLNG) and Gas Export Projects

The Nigerian Liquefied Natural Gas Company limited (NLNG), a joint venture between the Federal government and foreign oil majors was set up to harness Nigeria's vast natural gas resources and produce liquefied natural gas for export purposes. The NLNG generates benefits by creating value for the country's natural resources and making a major contribution to putting out the gas flares in Nigeria.

The NLNG is the only major gas development and investment in Nigeria to date. The plant is built in Forcados, Bonny island of Rivers state of Nigeria and was completed in 1999. Nigeria ranks 4<sup>th</sup> in the global LNG export market (table 1.1) and accounts for about seven percent (7%) of the world's LNG usage. The NLNG plant complex has been described as 'Africa's largest single private sector industrial project' and the company is the biggest single contributor to government's efforts to diversify the Nigerian economy and income portfolio (Omotowa, 2013). With six trains currently operational, the entire complex is capable of producing 22 metric tonnes per annum (mtpa) of LNG, 4 mtpa of LPG and 2.4 mtpa of condensate which is roughly 7% of the world's LNG consumption.

The LNG technology makes natural gas available throughout the world. Some of the gases that would otherwise be flared is converted to the LNG. This reduces the environmental impact of continuous flaring of large quantities of natural gas.

- The Nigerian LNG Ltd (NLNG) is jointly owned by the Nigerian National Petroleum Corporation (NNPC), Shell, Total and ENI. The company was incorporated in 1989 to harness Nigeria's vast natural gas resources and produce Liquefied Natural Gas (LNG) and Natural Gas Liquids (NGLs) for exports. The NLNG also supply the Liquefied Petroleum Gas (LPG) to the local market and currently supplies about 80% of domestic gas used by Nigerians (Omotowa, 2015). The NLNG ltd is a major player in Nigeria's gas sector and the pioneering producer and exporter of liquefied natural gas in Nigeria. The Liquefied Natural Gas (LNG) facility on Bonny Island was completed in 1999. The NLNG has two wholly owned subsidiaries: Bonny Gas transport and the NLNG Shipping Manning Limited. Initially, the facility is to be

supplied from dedicated non associated gas fields, but within a few years it is anticipated that half of the input gas will consist of associated (currently) flare gas.

Construction of a third LNG production train with an annual capacity of 130.6 bcf was completed and operational in December 2002 which increased the overall LNG processing capacity to 383 bcf per day. To date, trains 4, 5, and 6 have been completed. The seventh train is awaiting government sanction. The Final Investment Decision (FID) for Train 7 was supposed to be taken in 2008 but for the challenges that have arisen. The driven force for this huge investment has been a ready and attractive market for gas in Europe, Asia and America. At present, the NLNG has become a reliable supplier of LNG in the Atlantic basin, Far East and American destinations.

Apart from the NLNG project, other Greenfield projects in Nigeria are:

- Brass Liquefied Natural Gas (Brass LNG) Project – The Brass LNG Ltd is a liquefied natural gas company incorporated in December 2003 by NNPC (49%), ConocoPhillips (17%), ENI international (17%) and Total (17%). This is a Greenfield project located on Brass River in the Bayelsa State of Nigeria. It will export her products to the Atlantic Basin market (North America and Europe) where it seeks to become a key player. The business strategy is to reduce gas flaring and also provide opportunity to monetize part of its vast natural gas reserves. The contract for the Front End Engineering Design (FEED) of the proposed LNG facility was awarded in late 2004. The FEED was for two LNG trains, each nominally sized at 5 Million metric tons a year. The primary FEED studies were conducted in 2005 with further optimization in 2006 which paved way for the competitive Engineering, Procurement and Construction (EPC) tendering process. The Brass LNG shareholders are yet to sign the final Investment Decision (FID). Though the actual cost of the Brass LNG project is uncertain, the pre-FID expenditure has gulped over \$700 million, an indication of the confidence of investors in the project. Recently the NLNG Japan Corporation specifically seeks to be involved in the Brass LNG Project. The LNG Japan Corporation was established in 2001 as an energy trading house taking strategic initiative in the LNG business. Brass LNG is the starting point in LNG Japan's West African drive as it has been involved in LNG projects in Indonesia and Qatar mainly.
- Olokola Liquefied Natural Gas (OKLNG) Project - This LNG project, which is also a greenfield project is located on the coast between Ogun and Ondo states, east of Lagos, Nigeria. Following the outcome of two separate studies conducted by Chevron/BG and Shell that proposed to NNPC the development of their respective Greenfield LNG Projects in the Olokola area. The NNPC, Chevron, BG International Ltd and Shell Gas and Power Developments BV (Shell) on April 13, 2005 signed a Memorandum of Understanding (MoU) for the LNG Plant, with 2009 and 2010 as target shipment dates respectively. The vision is to develop 22million metric tons per year (mtpa) capacity, to be executed in phases. It was, however, not feasible for the project to come on stream in 2010 as planned. OKLNG is designed for processing domestic gas and field condensate in addition to LNG production.
- Olokola LNG Upstream Gas Supply project– The project, on completion will provide the NNPC/CNL JV portion of gas needed for the OK LNG project to be sited in the OK Free Trade Zone located on the coastline of Ogun and Ondo states of Nigeria.

## **2.1 Other Gas Export Projects**

Other Gas export projects apart from the LNG projects are Escravos Gas to Liquids (EGTL), Escravos Gas Project (EGP), Oso Natural Gas Liquid (NGL), West African Gas pipeline Project (WAGP)

- Escravos Gas to Liquids Project – The Escravos Gas to Liquids (EGTL) is another Chevron's multi billion project that will convert about 300 million cubic feet per day of residue gas (methane and ethane) into 34,000 barrels of high quality, environmental friendly diesel fuel, naphtha and liquefied petroleum gas (LPG). The EGTL project site, reclaimed through dredging, sand filling and dewatering is located about 100km south east of Lagos in a swampy gas-rich terrain at the mouth of Escravos River. The project is the largest in Africa and world's second largest (coming after Qatar's ORYX GTL). Preliminary discussions on EGTL project was initiated in the late 90's between NNPC and Chevron Nigeria Ltd. The EGTL which is being modeled after Qatar's ORYX GTL is designed to process ultra-low sulphur GTL products. Thus allowing commercial flexibility in monetizing Nigeria's huge gas reserves. Both GTL Diesel and Naphtha products will be marketed in line with the terms of an off-take agreement while the LPG will be sold back to EGP for co-mingling and export with the upstream JV LPG. The EGP is unique because that it signals the beginning of an effort to end gas flaring and also opened for Nigeria a new source of foreign exchange earnings through the export of its by-product especially Liquefied Petroleum Gas (LPG).

The EGTL project receives about 300 MMSCFD of residue gas (lean gas) feedstock from the EGP and converts same and achieve peak production rates of 22,100BPD of synthetic diesel, 10,200 BPD of naphtha and 7,500

BPD of LPG. This technology is provided by Sasol Chevron Holding Limited (SCHL), a joint venture between Sasol Limited of South Africa and Chevron Corporation.

The Escravos Gas Project (EGP) is one the first major gas project to gather and process associated natural gas in Nigeria. This project is a joint venture project between NNPC (60%) and Chevron Texaco (40%) to recover associated gas (AG) from offshore fields. The first shipment of Liquefied Petroleum Gas (LPG) came on stream in 1997. This is a key element in Chevron Texaco's initiative to reduce gas flaring and utilize gas economically from Chevron's north offshore Fields. The NGLs are stripped for export and the remaining gas is used domestically.

- Oso Natural Gas Liquids (NGL) Project – This project is a joint venture between NNPC (49%) and Exxon Mobil (51%) to convert associated gas into Natural Gas Liquids (NGLs). Mobil Producing JV NGL plant is located in the southeastern part of Nigeria. This NGL recovery project was commissioned in November 1998 and designed to monetize associated gas. The project's current production capacity is 50,000 barrels per day. The financing and award of EPC contracts for the expansion of existing facilities was concluded in December 2004. This Project has substantially reduced the amount of gas flared in Mobil's operational area.

## **2.2. West African Gas Project (WAGP)**

The West African Gas Pipeline Project (WAGP) is a joint venture between Chevron West Africa Pipeline Limited (36.7%), Shell Overseas Holdings Limited (18%), NNPC (25%) represented by the Nigerian Gas Company (NGC), SocieteTogolaise de Gaz (2%), Societe Ben Gas S. A. (2%) and Takoradi Power Company Limited (16.3%) for the extension of the existing Escravos to Lagos Pipeline (ELP) to Takoradi, Ghana. This project will transport gas from Nigeria to Ghana, Benin and Togo. It is also possible that the WAGP will be extended to markets in Cote d'Ivoire. Negotiations are on with a number of prospective buyers in the sub region. This project will traverse about 618km high pressure natural gas pipeline to transport natural gas produced in the Niger delta to power generation and industrial facilities in Ghana, Togo and Benin. The pipeline will have initial capacity to transport about 170 mmscf/d of gas from Nigeria to market centres in Benin, Togo and Ghana.

Further to the Treaty on the West African Gas Pipeline project that was entered into by the Federal Government of Nigeria, the Republics of Ghana, Benin and Togo in 2003. The Federal Government of Nigeria signed the West Africa Pipeline Act into law in 2005, in order to provide the legal regime for the implementation of the treaty.

Among the key conditions for this project are:

- The sale, transmission and purchase of natural gas must be performed on a commercial basis
- Third Party access to WAGP must be granted on a non-discriminatory basis
- The pipeline company and the sellers of natural gas must be guaranteed settlement in hard currency.

## **III. LNG and Gas Projects in similar countries**

It is observed that some of the countries with less gas reserves than Nigeria (Egypt, Algeria, and Australia) have been able to use their gas resources to adequately meet their domestic and export needs to develop their countries. Using the current gas management in these countries and specifically the successful LNG Projects, it shows that Nigeria gas reserves can also be used adequately for domestic and export purposes and also for developmental purposes. The successful LNG business and operations in Qatar is also of particular interest to Nigeria.

Qatar has over the years built the largest Liquefied Natural Gas (LNG) and Gas to Liquid (GTL) industry (Pearl, Oryx, Palm) in the world along with Petrochemical industries. Today, these projects are generating more than one hundred billion dollars a year (Omotowa, 2015). Qatar has also created opportunities across the value chain by establishing three mega industrial cities of Mesaieed, RasLaffan and Dukhan which now provides operational and maintenance support for the gas industry. Qatar has been transformed from a small emirate to a leadership position as a country with the largest Liquefied Natural Gas (LNG) and Gas to Liquid (GTL) industries in the world with strong commitments and alignments of the gas policies. This strategic integrated approach to industrialisation has enabled the sustainable retention of about 1.3million jobs. All these were done under a partnership approach attracting both international financial and technical expertise in a win-win manner (Omotowa, 2015). This kind of model applied can therefore provide a Master plan for harnessing Nigeria's abundant gas resources especially for LNG projects. The progressive buildup of Qatar capacity in the late 1990's allowed the Middle East to emerge as the largest exporting region. For almost ten years in a row, Qatar remained the largest LNG exporter, providing to the market approximately one-third of the global supply (IGU, 2015). The world's five largest LNG importers are Japan, South Korea, China, India and Taiwan.

#### **IV. Conclusions**

- i. The only major investment in gas development in Nigeria has been the LNG projects. Some of the gas that would otherwise be flared are converted to the LNG. Other gas export projects in Nigeria apart from the NLNG are Escravos Gas to Liquids (EGTL), Escravos Gas project (EGP), Oso Natural gas Liquid (NGL) and West African Gas pipeline (WAGP).
- ii. Over the past few years, many of the big oil and gas companies operating in Nigeria are involved in developing and operating LNG supply chains and look forward to take Final Investment Decisions (FID) on LNG. Nigeria is the 4<sup>th</sup> largest exporters of LNG in the world.
- iii. Some countries are increasing their LNG market share through consistent massive capital investments, Qatar and Australia are good examples. In the case of Nigeria, gas reserves are enormous but there seems to be unstable fiscal terms that have led potential investors to delay commitments for several years on new LNG projects. LNG Projects are expected to provide good returns to investors as observed in the NLNG but good incentives are required as high capital investment and long construction times result in projects requiring tax relief during the early years. In addition, LNG projects are competing internationally and it is a general international practice to grant incentives to such projects.
- iv. The emerging market for floating liquefaction plants will also be useful in the deepwater areas of the Nigeria's Niger delta where substantial gas reserves have been discovered with more potential of undiscovered reserves which are currently stranded. The industry is however watching developments in FLNG projects closely, particularly the costs to deliver such projects and the achievable operating efficiencies.
- v. Some of the countries with less gas reserves than Nigeria (Egypt, Algeria, and Australia) have been able to use their gas resources to adequately meet their domestic and export needs to develop their countries. Using the current gas management in these countries and specifically the successful LNG Projects, it shows that Nigeria gas reserves can also be used adequately for domestic and export purposes and also for developmental purposes.

#### **BIOGRAPHY:**

1. CARIM, A. Akintunde, had a BSc degree in geology and MSc degree in Petroleum geology from the University of Ibadan, Nigeria. He also obtained a MBA in Technology management. He is currently a PhD student in Technology management at the Institute of Engineering, Technology and Innovation Management (METI), University of Port Harcourt.
2. Adewale Dosunmu is a Professor of Petroleum Engineering in the department of petroleum and gas engineering, University of Port Harcourt, Nigeria and the Shell's Aret Adams Chair in Petroleum Engineering. Professor Dosunmu is also a consultant to several Oil and gas companies in Nigeria and overseas. He has served previously as an SPE Distinguished Lecturer and he is a member of several professional societies including the Society of Petroleum Engineers (SPE) and the Nigerian Society of Engineers. He is a visiting Professor to several Universities offering courses in petroleum and gas engineering.

#### **REFERENCES**

- [1] Wood, D. (2012): A review and outlook for the global LNG trade; Journal of Natural gas and engineering, page 16-27
- [2] Ekaluo, A.B (2015): "Harnessing and monetizing the potential of stranded gas fields-A key enabler for economic and national growth", NGA conference, 22<sup>nd</sup> July.
- [3] Emelumadu, U. (2012): "Utilisation of Nigeria's Gas resources – Perspective of the journey so far", NAPE pre-conference workshop, 9<sup>th</sup> October.
- [4] Ige, D. (2012): "Government Policy Execution as it affects gas development in Nigeria", NAPE Pre-conference Workshop, 9<sup>th</sup> October.
- [5] IGU World LNG Report 2015: International Gas Union (IGU)
- [6] Olorunsola, A. (2012): "Defining an effective gas commercialization policy for Nigeria", NAPE pre-conference, Workshop, 9<sup>th</sup> October.
- [7] Omotowa, B. (2012): "Natural Gas – sustaining Nigeria as a major player in the global gas business amidst competition from other energy players", NGA conference, 28<sup>th</sup> November
- [8] Omotowa, B. (2013): "Financing Nigeria success story – NLNG", annual capital committee retreat, November
- [9] Omotowa, B. (2015): "Gas – Dominant energy of the future", NOG, 16<sup>th</sup> - 19<sup>th</sup> March
- [10] Oniwon, A (2011): "Gas Utilization for long term clean energy and economic growth", SPE conference, NAICE, 3<sup>rd</sup> August.
- [11] Osahon, G. (2014): "State of the domestic gas market", NAPE Pre-conference Workshop, 10<sup>th</sup> November
- [12] Yakubu, A. L (2011): "Developing the Nigerian Gas Market, Commercializing existing discoveries and encouraging gas exploration", NAPE Pre-conference Workshop, 25<sup>th</sup> October.