

## Optimizing Natural Gas Assets from Marginal Fields in Nigeria

Koso I.I.\* and P.N. Onwuachi-Iheagwara\*\*

*\*\*Department of Petroleum and Gas Engineering, University of Benin, Benin City, Nigeria*

*\*Delta State University, Abraka, Oleh campus, Oleh, Nigeria*

*Email: \*kiidigbe@gmail.com; \*\*pniheagwara@gmail.com*

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### ABSTRACT

*This paper presents the results of the investigations on effectively integrating natural gas to getting the best economic values from marginal fields. Effective organograms and assets management are major keys that will drive the exploitation and effective monetization of natural gas from these fields. Natural gas is an important input to the success of major sectors of the economy, and therefore, should be properly exploited from marginal fields.*

Keywords: Natural Gas, Economic Values, Marginal Fields, Assets Management, Monetization

### Introduction

Five major sectors of the economy are expected to play key parts in moving Nigeria to effective development, namely:

- Energy, specifically, petroleum
- Power,
- Steel,
- Agriculture, and
- Transportation.

The common parameter between these sectors is natural gas. Nigeria is blessed with over 180 trillion standard cubic feet of natural gas reserves – conventional and unconventional <sup>(1, 2)</sup>. Over 80 percent of the conventional reserves are held by the major companies – IOCs and Independents, in their various fields <sup>(3, 4)</sup>. The natural gas assets in Nigeria are mainly: natural gas and natural gas liquids. These gas assets are very “sweet” and valuable, with very low values of hydrogen sulphide and other compounds

of sulphur, oxides of carbon and nitrogen. Over the years, we witnessed the flaring and economic waste of the produced conventional associated natural gas. However, due to subsequent policies and incentives by the Federal Government of Nigeria <sup>(5)</sup>, associated natural gas flare down is currently less than 75% of all daily gas production. The flaring of produced associated natural gas has presented many problems, namely:

- The compromise (pollution, de-gradation, etc.) of the environments --- air, water and land,
- Cultural dis-equilibrium --- relocation of communities; new way of life for members of the re-located communities, loss of income, etc.,
- The threats to the health and safety of the people within the areas of flaring,
- The lack of effective disaster management, and
- The economic loss to all parties --- the Federal Government, the Operators and Communities.

Table 1 shows the estimated lost income from the flaring of natural gas for the years 1999, 2000, 2001 and 2002. At present price value of about \$85 per boe, this translates to a huge economic loss for Nigeria.

**Table 1: Lost Income<sup>(3)</sup>**

Year	Volumes Flared (bscf)	Loss at \$20/bbl (\$billions)	Loss at \$18/bbl (\$billions)
1999	824	2.88	2.59
2000	905	3.13	2.82
2001	944	3.25	2.93
2002	862	3.02	2.71

**Boe = barrels of oil equivalent**

However, the Federal Government of Nigeria is presently debating a gas flare down policy that will mandate the cessation of all flaring of natural gas, through the anticipated natural gas master plan. This policy will be mandatory for all companies – major and

marginal fields' operators. We posit that the natural gas reserves in the marginal fields, if effectively exploited, will contribute in driving some of the five sectors of the economy mentioned earlier.

## NATURAL GAS PROJECTS

At present, various economic projects are on ground to minimize and thus, monetize the produced associated gas being flared. These projects can be classified into three major groups, namely:

- Export oriented,
- Domestic oriented, and
- Field utilization.

The main natural gas projects on stream, by some of the major operators, are:

- The Gas Re-injection/Field Use projects,
- The Natural Gas Liquids (NGLs) project of Mobil Producing,
- The Gas-to-Liquid (GTL),
- The Liquefied Natural Gas (NLNG) project of Shell/Elf/Agip,
- The West Africa Gas Pipeline, and
- Independent Power Plants (IPP).

Other major natural gas projects being planned by the major companies are:

- Enhanced LNG Trains by NLNG,
- New LNG plant by Mobil Producing, Agip, etc.
- Enhanced Independent Power Generation,
- Enhanced Industrial Use by Local Industries, and
- The Liquefied Petroleum Gas (LPG) project of ChevronTexaco.

At present, the NLNG substantially accounts for gas utilization in the export-oriented projects. The power sector is expected to account for about 60% gas utilization within the domestic oriented projects<sup>(6)</sup>. This is expected to generate additional power into the

national grid, to complement PHCN. The following domestic markets for natural gas are gaining momentum and appreciation:

- Distribution of lean natural gas to industrial areas,
- Steel and Aluminum,
- Fertilizer - Agriculture,
- Cement and Glass, and
- Transportation - CNG.

The major field utilization projects are in:

- Gas lift schemes,
- Gas re-injection schemes, and
- Natural gas as fuel for field uses.

Very large volumes of natural gas are required for some of the above projects, and can only be met by the major producers. Table 2 shows the average volumes of natural gas for some of the projects <sup>(1, 3)</sup>.

**Table 2: Gas Utilization<sup>(1, 3)</sup>**

Category	Volumes Utilized (mmscf/day)
Field Use/Re-injection	about 200
LNG	Over 1000
Domestic Markets	about 600

In Nigeria, the monetization of natural gas was not a major input to the overall business strategies of the major and marginal field companies. Natural gas was perceived as an unwanted by-product of crude oil production. Natural gas flare down was not functionally integrated to the exploitation and management of the huge assets – oil and gas, especially, of the IOCs and Independents.

## MARGINAL FIELDS

In 2003, the Federal Government of Nigeria awarded twenty-four (24) marginal fields to indigenous companies for exploitation<sup>(7)</sup>. Many of these marginal fields are characterized by:

- Low reserves of crude oil (Less than 20 million stock tank barrels of crude oil),
- Low crude oil daily production rates (Expected or producing less than 4,000 stb/day),
- Economic life of about eight to fifteen years,
- Low to moderate net present values (NPVs), and
- Low natural gas reserves (less than 100 bscf: AG and NAG).

For example, Table 3 shows the basic statistics for three of these marginal fields<sup>(7, 8)</sup>.

**Table 3: Assets Statistics** <sup>(7, 8)</sup>

Field	Reserves Crude Oil (mmstb)	Daily Oil Prod. Rate (stb/day)	Reserves Gas (bscf)
Akepo	~ 20.00	~ 2,000*	~ 41.550
Ajapa	~ 32.00***	~ 2,300**	~ 65.6000***
Oza	~ 15.00	~ 2,000*	~ 25.000

\*Expected; \*\*Present Production (2013), \*\*\*Revised Volumes (2008)

From the values, it is clear that there must be a properly articulated and planned integrated gas flare down program to enhance the economics and management of the assets of the marginal fields, as presently been advocated by the DPR. Many of the producing marginal fields are using less than one percent of daily produced associated natural gas. We ask the following questions:

- What options must be put in place for natural gas, to bring the best economic performance for each marginal field?

- How will the marginal fields’ operators meet the gas flare down policy of the Federal Government?
- Will these be consistent with the development strategies and economics of the assets – crude oil and natural gas?
- Can these companies integrate the mandatory gas flare down policy into the exploitation and effective management of their marginal assets?

## ECONOMIC ASSETS

The following assets are available to the marginal field companies for monetization:

- The crude oil, and
- The natural gas assets.
  - ✓ The associated dissolved gas (AG),
  - ✓ The non-associated gas (NAG), and
  - ✓ The natural gas liquids (NGLs)

Table 4 shows the economic indicators for the three fields with statistics in Table 3. The indicators were exclusively prepared considering only the crude oil assets<sup>(7, 8)</sup>. The results in Table 4 are indicative of the twenty four marginal fields<sup>(7)</sup>.

**Table 4: Economic Indicators from Crude Oil Assets <sup>(9)</sup>**

Field	Life years	TC \$mm	PT years	IRR %	NPV \$mm
Akepo	13	129.4	4.2	48.8	31.24
Ajapa	~ 15*	200.00	5	Above 70	Above 60
Oza	12	76.04	4	32	9.59

**\*Revised; PT = Payout Time**

Additional net income can only come from the effective exploitation and monetization of the natural gas assets. The companies must seek innovative natural gas assets

management solutions for their fields. These solutions must be properly integrated into overall field assets management, through effective field development plans.

## **GAS FLARE DOWN**

The Federal Government is planning a complete gas flare down in all fields – normal and marginal. The marginal fields’ operators must develop a master plan for natural gas. The basic components of this master plan are:

- How to achieve gas flare down in their fields – gas development and monetization strategies,
- Overall management of producing reservoirs to achieve economic targets e.g. projected life of fields, etc.

At present, about five of the marginal fields are in production. The agreements with the farmers – the original operators of the fields, were signed in March 2004. Some of the farmees – the marginal fields’ operators, are still sourcing for technical partners and funds. If and when all the marginal fields are put on production, the operators can:

- Produce only the associated dissolved gas (AG) from the crude oil.
- Produce both the associated dissolved gas (AG) and the non-associated gas (NAG), if there are NAG reservoirs in each field.

How can the marginal fields’ operators achieve gas flare down? Depending on each company’s preferred gas project(s), we posit the following:

- Plan effective overall field development (FDP) for both crude and natural gas, which must be updated as more data are acquired, and
- Put in place strategies for gas processing and monetization, through:
  - ✓ Take any produced natural gas to the nearest available processing facility of any company.
  - ✓ Built facilities to process any produced natural gas to value.

The FDP may be out-sourced for better technical input and audit, as shown in Figure 1. Initially, the operators may not have the funds to build facilities. They will then take any

produced gas, most probably only produced associated gas, to the nearest facilities of the major companies for processing. This is an option DPR gave to the indigenous companies<sup>(7)</sup>.

## **NATURAL GAS (FROM MARGINAL FIELDS) TO VALUE**

The proposed marginal fields” master plan for natural gas should satisfy the following decisions to convert the produced gas to value.

- Produce only the associated dissolved gas, and monetize the gas to value. Monetization of gas by selling the gas to the owners of nearby processing facilities. This option will not optimize income from the gas.
- Lease facilities (mobile or fixed) for processing and monetize the gas. This is a better option but will depend on the volumes of produced gas. This is a good option if non-associated gas is produced from the onset.
- Synergy of efforts by companies in the same Oil Mining Lease (OML) or nearby OMLs into collectively turning all produced gas into value.
- If and when to produce the non-associated gas (NAG). Monetization of the gas to achieve optimum income.
- The optimum monetization of all produced gas – associated and non-associated.

The optimum monetization of produced gas from the marginal fields will never come from the sale of gas to the major companies for a token price. The marginal field companies must monetize the gas themselves for better income. How?

## **MONETIZATION**

They are two avenues for the monetization of natural gas available to marginal field companies, namely:

- Commercial
- Industrial



What projects are then feasible to integrate gas flare down to getting the best economic performances from these marginal fields? The natural gas in the marginal fields varies from field to field, such as <sup>(7)</sup>:

- Retrograde Gas – expected to yield very high volumes of hydrocarbon liquids (NGLs).
- Wet Gas – expected to yield moderate volumes of hydrocarbon liquids.
- Dry Gas.

The natural gas projects will depend on a clear classification of an operator's type of gas for optimum exploitation and monetization. However, the following gas projects are technically and economically feasible for these fields <sup>(2, 10)</sup>. They can easily be integrated into assets management, to subsequently achieve an effective gas flare down – gas to products.

- Compressed Natural Gas Projects (CNG <sup>(11)</sup>)
- Processing into Individual Components for Particular Industries, such as:
  - ✓ **Methanol Production:** Field and Industrial Uses - Depression of dew points of gas streams, vehicular uses, natural gas dehydration, etc.

The potential for Methanol in Nigeria is enormous. There are presently no major methanol plants in Nigeria. A few are being planned. The marginal field companies can initiate the production of methanol from their fields. Synergy between fields in the same OMLs is ideal.

- ✓ **Ethane (C<sub>2</sub>) Extraction:** A major feed to the petro-chemical plants currently undersupplied with ethane.

The petro-chemical plant at Eleme, Port Harcourt, is marginally functional because of shortages of ethane. We posit that the natural gas – associated and non-associated, in the marginal fields should be processed into various components, especially C<sub>2</sub>H<sub>6</sub>, ethane.

- ✓ **LPG Extraction:** Exclusively for domestic and industrial uses.

This could either be individual components, C<sub>3</sub>H<sub>8</sub>, C<sub>4</sub>H<sub>10</sub>, or the mixed components – the mixed LPG. This product is presently imported since our refineries are not working. The refineries will definitely not meet future demand. At present, ChevronTexaco produces mixed LPG from their Excravos EGP project. This LPG and that from the NLNG at Bonny are exclusively for exports.

- ✓ **NGL mix (unfractionated):** e.g. C<sub>5+</sub> for crude oil spiking; naphtha for high quality natural gasoline and diesel.

The marginal field companies will effectively contribute to the sustainable development of Nigeria if they embark on these gas projects. Abundant markets exist for these gas products in Nigeria and the West African region. For example in Nigeria, there is presently, only one source of LPG for domestic use – imports. With a population of about 140 million people, the market for LPG is enormous <sup>(10, 11)</sup>. As new markets emerge, new projects could be started. The right policies and mandates of the Federal Government will definitely help in the optimum monetization of natural gas from the marginal fields.

## **ORGANIZATIONAL STRUCTURES AND ASSETS MANAGEMENT**

By April 2013, only five of the twenty four (24) marginal fields awarded in 2004, are producing. This is not very encouraging. An expected best practice for the marginal field companies will be proper and effective organizational structures (ORGANOGRAMS). However, the “one individual syndrome”, seems to be playing out in many of the companies. We do not expect very large organograms for these fields, knowing the quantity of assets in these fields, but at a minimum, a simple effective one that will drive the fields to success. Poor organograms and assets management by the marginal fields’ operators can lead to:

- Less efficiency and effectiveness in operations,
- Higher operating expenses,
- Lower income from the fields, and

- Fewer reserves of both crude oil and natural gas extracted from the fields – poor reservoir and fluids” management.

We present a very simple, lean and effective organogram <sup>(8)</sup> for these fields in Figure 1. Gas flare down is a major and integral component of effective assets management in the marginal fields. To maximize value from the associated gas (AG) and subsequently from any produced non-associated gas, the marginal assets operators, can collaborate – develop an effective synergy, by:

- Sharing resources – engineers, contractors, consultants, etc.
- Sharing knowledge about fields, methods of development, cost-effectiveness in operations, etc.
- Sharing assets, e.g. same plants; same pipelines to convey gas to dedicated plants at a location.
- Long-term relationships on gas markets, gas projects, etc.

At present, we see none or little of these among the operators of marginal fields in Nigeria, even when they are in the same OML. Operators in the same or nearby OML’s should be encouraged to come together and manage any gas project <sup>(8, 9)</sup>.

## CHALLENGES

Gas flare down and the success of any natural gas project in the marginal fields, will depend on the effective management of challenges <sup>(12)</sup>. We believe the greatest challenges are poor organograms and assets development/management. Operations can be optimized if and when the following are met:

- Recognizing any challenges, such as poor organograms, community relations, etc.
- The effective control of the challenges,
- The continuous monitor and audit of contingencies put in place to contain the challenges (see Figure 1), and

- The effective synergy between the marginal fields' operators and the host communities, towards uncertainties and disasters <sup>(13)</sup>.

All likely challenges, uncertainties and disasters must be clearly articulated, defined and categorized. The ability to anticipate and recognize challenges must be cultivated and cultured. Effective communication between parties, is an essential tool in managing any challenges, and should be encouraged. All gas projects must on the long term, be socially, technically and economically friendly, effective and sustainable, so as to impact positively on the people and the nation. The projects must not be allowed to go the way of the:

- The Refineries,
- The Petro-chemical Plants, and
- The Pipelines.

The continuous and objective audit of all projects, and the anticipation of and effective management of challenges must become a culture. The time-lapse documentation of performances is very vital. The desire to effect changes must be a major part of overall strategy of the marginal fields' operators.

## **INVESTMENT AND FUNDING OPTIONS**

For many of the marginal fields companies, it will not be financially feasible to undertake the gas projects by themselves. It is envisioned that local banks and investors, particularly foreign partners, will participate in these gas projects through the "Build and Manage" funding arrangements:

- The investors will Build/Own the gas plants, while the operators will lease and operate.
- The investors will Build/Own gas pipelines, while the operators will lease and operate.

The Build and Manage funding will be by the banks and any investors. The facilities will be built and managed by the banks and any investors. This funding arrangement will enable the banks to participate in crude oil & natural gas business in Nigeria. This will go beyond the normal loan facilities. The banks being involved in the management of the facilities will ensure the profitability and success of the gas projects. The operators will be freer to participate in the core business of producing and monetizing the gas.

## CONCLUSIONS

Low volumes of natural gas assets characterize the marginal fields in Nigeria. The effective monetization of these gas assets must be an integral policy of the marginal field operators. Best economic performances must be continually achieved to sustain and guarantee the success of these indigenous companies. In this paper, viable suggestions are presented on how these companies could integrate their gas assets to meeting the gas flare down policy of the Federal Government, and subsequently manage and effectively monetize the assets in the marginal fields.

The requirements for success are presented. Best practices in operations – anticipating and meeting any challenges, is a major requirement that must be imbibed and cultured by the indigenous operators, to continually create and deliver value from operations. The gas markets for suggested projects are enormous in Nigeria and West Africa. The marginal fields' operators must contribute to the sustainable development of Nigeria. The gas projects are keys to achieving this.

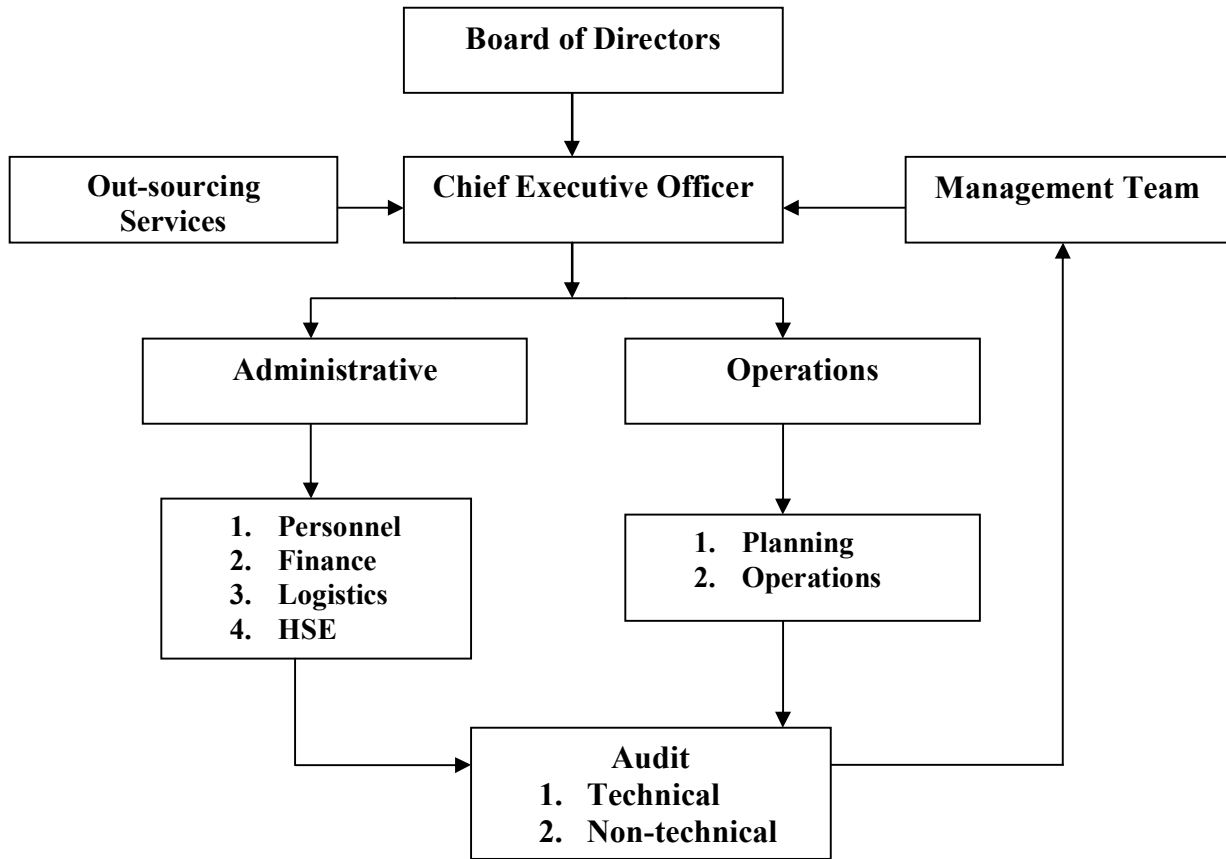
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## NOMENCLATURE

AG	=	Associated Gas
bscf	=	Billion standard cubic feet
E & P	=	Exploration and Production
DPR	=	Department of Petroleum Resources
IOCs	=	International Oil Companies
NAG	=	Non-associated gas
NAFCON	=	National Fertilizer Company of Nigeria
NAPIMS	=	National Petroleum Investments and Management Services
LNG	=	Liquefied Natural Gas
LPG	=	Liquefied Petroleum Gas
NGL	=	Natural Gas Liquids
NGV	=	Natural Gas Vehicles
MM	=	Million
mmscf	=	Million standard cubic feet
OML	=	Oil Mining Lease
Stb	=	Stock Tank Barrels
PHCN	=	Power Holding Company of Nigeria



**Figure 1: Simple Organogram to Drive Marginal Fields**

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**Bibliographic Note:** Koso I. Idigbe obtained B.Sc, M.Sc, and PhD. Degrees in Petroleum Engineering from the University of Texas at Austin, Texas, USA. A COREN Registered Engineer with over thirty years experience in both industry and academics. At present, he teaches Petroleum Engineering at the University of Benin, Benin City, Nigeria. Koso I. Idigbe has participated in many Petroleum Industry activities, mostly notably, representing the African Region of the Society of Petroleum Engineers (SPE) as the Representative in the Distinguished Lecturers Committee. He has over the years participated in Natural Gas utilization seminars, and has published papers on the value of Natural Gas to the Nigerian Economy and Development.



**Bibliographic Note:** P.N Onwuachi-Iheagwara is a lecturer in the Department of Petroleum and Gas Engineering at the Delta State University, Oleh campus. Obtained B.Sc in Geology from the University of Ilorin Kwara State, Diploma in Computer Studies from the Computer Training Institute, Warri, PGD in Petroleum Engineering from the University of Benin, Edo State, M.Sc, in Mechanical Engineering from the University of Nigeria, Nsukka, M.Eng. in Petroleum Engineering from the University of Port Harcourt, Rivers State and PGD Education from the National Teachers' Institute, Kaduna State. She is currently on a PhD Petroleum Engineering program at the University of Benin, Nigeria.

Patricia Nneka Onwuachi-Iheagwara is a member of several professional associations and societies including: the Nigerian Society of Engineers, (NSE), and Nigerian Association of petroleum Explorationists (NAPE), Nigerian Mining and geosciences society (NMGS), the Society of Petroleum Engineers (SPE) and the Nigerian Institute of Industrial Engineers, NIIE. She is an associate fellow of Institute of Industrial Administration of Nigeria, IIA. She is an ORACLE Certified Associate (OCA) and ORACLE Certified Professional (OCP), registered with the Council for Nigerian Mining Engineers and Geoscientists, COMEG and with the Teachers Registration Council of Nigeria (TRCN).

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