Gas Monetisation and Commercialisation

Gas Network Code – Issues and Challenges
PRESENTATION OUTLINE

The Nigerian Gas Sector
- Gas Market Overview
- Resources (Volumes, TCF)
- Monetization & Commercialization

Nigerian Gas Infrastructure
- Infrastructure Blueprints
- Available & Ongoing Projects
- West African Gas Pipelines (WAGP)
- Gas Compositions & Specifications

Network Code Development
- Background
- Issues & Challenges
- Conclusions
Nigeria Gas Market Overview – Power Sector

Key Challenges

<table>
<thead>
<tr>
<th>Installed Capacity</th>
<th>14,000 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Hydro 1938MW</td>
</tr>
<tr>
<td></td>
<td>• Thermal 12,200 MW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operational Capacity (Thermal)</th>
<th>3,500 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Gas requirement</td>
<td>3,500 MMscf/d</td>
</tr>
<tr>
<td>Current Gas Supply</td>
<td>600-850MMscf/d</td>
</tr>
<tr>
<td></td>
<td>24% of daily feed gas requirement</td>
</tr>
</tbody>
</table>

Key Challenges facing the Power Sector (major Domgas customer):

1. **Gas Availability:**
   - Unprecedented pace of growth in demand relative to feed gas supply
   - Insecurity & pipeline vandalism in the Niger Delta

2. **Gas Deliverability:**
   - Inadequate gas transportation and processing infrastructure

3. **Commerciality of Supply:**
   - Regulated Gas Pricing
   - Value Chain Issues: Securitisation of payment / unpaid bills, weak and unenforceable GSPAs
Commercialization and Monetization

“OVERVIEW”

Gas Master Plan Designed to ensure full blown domestic market by 2015:

- Gas infrastructure Blueprint
  - About 590km of pipelines completed and commissioned
  - All available power plants connected to gas supply pipelines
  - Additional pipelines under construction or contracting

- Domestic Gas Supply Obligation

- Commercial Framework (Pricing Policy) via the National Domestic Gas Supply & Pricing Regulations of 2008

- New National Gas Policy approved by FEC in 2017. “Policy drive is to ensure gas supply to the power sector as the country’s number one priority

Ref.
• Solving the Challenges in the Domestic Gas Value Chain. DPR presentation to DGSO Stakeholders forum 02 Nov. 2017
• National Gas Policy 2017: “to move Nigeria from an oil-based to an oil and gas-based industrial economy

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The Nigerian Gas Sector – A Dashboard

**Gas Reserves**
- TCF: 199
- TECH: 188
- BSCFD: 192

**Gas Production**
- BSCFD: 8.30
- BSCFD: 8.24
- BSCFD: 7.43

**Export Market**
- LNG / WAGP: 37%
- 40%
- 43%

**Domestic Market**
- POWER / INDUSTRIAL / COMMERCIAL: 15%
- 16%
- 17%

**Field/ Plant Use**
- FUEL / GAS LIFT / RE-INJECTION: 30%
- 33%
- 30%

**Flare**
- FLARE: 13%
- 11%
- 10%

**Undiscovered Gas**
- TCF: ?

**Additional Information**
- ENOUGH TO POWER NIGERIA FOR 100 YEARS
- AND GROW THE GDP BY X10
## Nigeria’s Gas Infrastructure

### “Infrastructure Blueprint – Current Status”

### Current efforts to sustain Gas Infrastructure Development

<table>
<thead>
<tr>
<th>S/N</th>
<th>Gas Pipeline</th>
<th>Capacity (MMscf/d)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Obiafu-Obrikom-Oben (OB3) Gas Pipeline</td>
<td>2,000</td>
<td>On-going.</td>
</tr>
<tr>
<td>2</td>
<td>ELPS II Pipeline</td>
<td>1,100</td>
<td>On-going.</td>
</tr>
<tr>
<td>3</td>
<td>Trans-Nigeria Gas Pipeline (TNGP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ajaokuta-Abuja-Kaduna-Kano (AKK)</td>
<td>1,600</td>
<td>EPC award stage</td>
</tr>
<tr>
<td></td>
<td>- Obigbo-Umuahia-Ajaokuta (OUA)</td>
<td>1,200</td>
<td>Proposal</td>
</tr>
<tr>
<td></td>
<td>- QIT-Obigbo Node-OB3</td>
<td>1,200</td>
<td>Tendering stage</td>
</tr>
<tr>
<td>4</td>
<td>Odidi-Warri Gas Pipeline Expansion Project (OWEP)</td>
<td>440</td>
<td>EPC award stage</td>
</tr>
<tr>
<td>5</td>
<td>Obiafu-Obrikom - OBOB (NAOC) – CTMS Pipeline</td>
<td>300</td>
<td>EPC awarded</td>
</tr>
<tr>
<td>6</td>
<td>Assa North/Ohaji South (ANOH) – OB3 CTMS</td>
<td>600</td>
<td>Tendering Stage</td>
</tr>
</tbody>
</table>
## Key Operational / Ongoing / Planned Facilities

<table>
<thead>
<tr>
<th>Type / Description</th>
<th>Capacity</th>
<th>Status / Outlook</th>
</tr>
</thead>
</table>
| **Bonny LNG**      | • Six(6) liquefaction trains  
                    • Production capacity  
                                 • LNG - 22m tons/year  
                                 • LPG - 4m tons/year | • Operational  
                                       • 7th train is planned. FID imminent |
| Brass LNG          | • Two liquefaction trains | • Yet to FID |
| Escravos-Lagos Pipeline System (ELPS) | • ELPS I operational (1989): Supplies natural gas from Escravos to Egbin power station – 800MMscf/d  
                                       • ELPS II – 1,100 MMscf/d | • ELPS II ongoing  
                                       • 2018 target completion date |
| West African Gas Pipeline (WAGP, 681KM, $900m) | • Natural gas from Escravos (ELPS 1) to consumers in Benin Republic, Ghana and Togo.  
                                         • 170 MMcf/day | • Operational late 2007  
                                         • Suboptimal feed gas (70MMscf/d) |
| Obiafu-Obrikom-Oben (OB3) Gas Pipeline | • 2,000 MMscf/day capacity | • Ongoing  
                                         • 2018 completion date |
## Key Operational / Ongoing / Planned Facilities

<table>
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<tr>
<th>Type / Description</th>
<th>Capacity</th>
<th>Status / Outlook</th>
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<tr>
<td>Trans- Nigerian Gas Pipeline (TNGP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Domestic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o Transport natural gas (4000 Mscf/d) from oil fields in Niger Delta</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Ajaokuta-Abuja-Kaduna-Kano (AKK) – 1600 MMscf/d</td>
<td></td>
<td>• $2.8billion dollar project approved by FEC Dec. 2017</td>
</tr>
<tr>
<td>• Phase 1 of TNGP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Obigbo-Umuahia-Ajaokuta (OUA) – 1200 MMscf/d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• QIT-Obigbo Node-OB3: 1200 Mscf/d</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Nigeria’s Gas Infrastructure
“Infrastructure Blueprint – Current Status”

Ref.
• Nigerian Gas Pipeline Transportation Company (NGPTC) presentation to DGSO Stakeholders forum 02 Nov. 2017
The West African Gas Pipeline:

- 681 km of high pressure gas pipeline (56 km of 30” between Itoki and the Lagos Beach compressor station, 569 km of 20” offshore between Lagos Beach and Takoradi, 20 km of 8” lateral in Cotonou, 19 km de 10” lateral in Lomé and 17 km of 18” lateral in Téma);
- 1 connexion and transfer point in Itoki
- 1 compressor station (Lagos Beach);
- 4 R&M stations (Cotonou, Lomé, Téma and Takoradi);
- Main pipeline:
  - Laid between 30 to 70 m water depth;
  - Located around 15 to 20km away from the coast.

- Total pipeline length ~ 690 km
- About 620 km built offshore
- Delivery points –
  - Cotonou (Benin)
  - Lome (Togo)
  - Tema (Ghana)
  - Takoradi (Ghana)
SIMPLIFIED SCHEMATIC OF EXISTING, ON-GOING AND PLANNED DOMESTIC GAS INFRASTRUCTURE

LEGEND
- Existing Pipelines
- ELP II On-going / Commissioned
- On-going OB3 Pipelines
- TNGP Pipeline (Early Gas Phase EGP)
- TNGP Pipeline (AKK)
- TNGP Pipeline (Phase 1)
- Odidi – Warri Expansion Pipeline (OEW)
- Existing & Planned Power Plants
- Other Industries

NORTHERN SYSTEM
- Escravos Gas Plant (EGP)
- Giga Gas CPF
- F. Yokri / S. Swamp CPF
- Utorogu Gas Plant (UGP)

WESTERN SYSTEM (ELPS)
- 490 MMscfd
- 300 MMscfd
- 240 MMscfd
- 180 MMscfd
- 140 MMscfd
- 80 MMscfd
- 60 MMscfd
- 30 MMscfd
- 15 MMscfd

EASTERN SYSTEM (ELPS)
- 510 MMscfd
- 320 MMscfd
- 200 MMscfd
- 100 MMscfd
- 45 MMscfd
- 40 MMscfd
- 36 MMscfd

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# Key Challenges to unlocking Development of Nigeria’s PSC Gas Resources

<table>
<thead>
<tr>
<th>Key Challenges</th>
<th>Issue/s</th>
<th>Enablers</th>
</tr>
</thead>
</table>
| Inadequate Infrastructure               | • Total installed/ planned capacity of 18.5Bscfd BY 2020 but, with the exception of the OGGS (capacity of 1.2Bscfd), there is no pipeline infrastructure to tie-in most shallow to medium depth (<200m) offshore gas resources, leaving them ‘stranded’. | ➢ Build more gas pipelines to increase geographic reach and link up offshore PSC gas to the existing/ planned infrastructure.  
➢ Power infrastructure improvement by TCN & DISCO’s – Modernisation of electricity transmission system |
| Legal & Regulatory Framework            | • Existing PSC’s are regarded as oil contracts, with gas ownership assumed to be that of the concessionaire.  
• The Strategic Gas Aggregator Concept not driven aggressively and delays in the NGTNC not helpful.                                                                                           | ➢ Gas Development Agreements / Gas PSCs (Cost recovery, Profit Sharing etc)                                                                                                                                 |
| Pricing and Fiscals                     | • Government controlled pricing mechanism through the 2008 National Domestic Gas Pricing regulation hinders / discourages investment.  
• Fiscals in the PIRB could adversely affect Gas investments (most are PSCs). Repeal of AGFA provisions in the PPTA for “Fiscal neutrality”                                                                 | ➢ Move from the NDGPR to a ‘willing buyer, willing seller’ pricing mechanism to unlock growth potential, allowing free market pricing of gas (driven by demand/ supply)  
➢ Gas fiscals to attract investments and grow economy |
| Funding Mechanisms                      | ➢ Investments in PSC oil projects are recovered from oil (cost oil). No mechanism is currently agreed for cost recovery or profit sharing for investments in gas projects                                                 | ➢ PSC funding is 100%, and so does not suffer the same cash-call constraints of JV funding. However, the mechanism for cost recovery and profit share on gas projects needs to be built into GDAs / Gas PSCs. |
Upstream: This involves the prospecting and exploration of petroleum resources. Exploration is carried out under an oil prospecting lease (OPL) which is converted to an oil mining lease (OML) upon discovery of commercial quantities of hydrocarbon. The Upstream segment is characterised by partnerships between NNPC and IOCs (International oil Companies), NNPC & Indigenous Oil Companies who operate JV (Joint Venture) agreements and PSC (Production Sharing Contract) agreements. “It is estimated that Nigeria’s undiscovered gas reserves range from 200 to 600 TCF. The quality of Nigerian’s gas is high – it is particularly rich in liquids and low in sulphur”.

Midstream: This involves processing and transportation of gas

Downstream: This involves the storage of natural gas in different form and distribution to consumers. Downstream distribution involves the transportation of natural gas and gas-to-liquid products from the refineries through pipelines, coastal vessels, tankers, road trucks and purpose-built vessels to different types of end users such as industrial plants, commercial users (hotels or accommodation estates), wholesalers and retailers as well as individual consumers.
Gas Business in Nigeria
Gas Value Chain

Upstream: Gas
- Exploration & Appraisal
- Production, Extraction & Gathering (AG, NAG)
- Utilisation – Improved Oil Recovery

Midstream
- Gas Conversion (Treatment & Processing)
- Transportation

Downstream
- Storage
- Local distribution & Marketing (LDCs)
- Direct Markets

Direct Markets
- Power Plants: DGSO
- Industrial

LDCs – Retail Markets
- Residential
- Commercial
- Industrial
- Power Generation
- Vehicle Fuel
# GAS SPECIFICATIONS

## WEST AFRICAN GAS PIPELINE SPECIFICATION

### NATIONAL GAS SPECIFICATION

Please note that the Nigeria Gas Master Plan envisages a national pipeline gas specification. Below is the proposed specification and can only be guaranteed by the gas producer.

### National Gas Specification:

1. **Composition**
   - a. Hydrocarbon Dewpoint: Min - 10°C (50°F), Max -
   - b. Water content: Min - 7lbs/MMScf, Max -
   - c. Methane (C₁): Min - 85%, Max - 95% by volume
   - d. Ethane (C₂): Min - 0%, Max - 10% by volume
   - e. Propane (C₃): Min - 0%, Max - 8% by volume
   - f. Butane + Paraffin (C₄+): Min - 5% by volume
   - g. H₂S: Min - 4 ppm by volume
   - h. Total Sulphur: Min - 28 ppm by volume
   - i. CO₂: Min - 4% by volume
   - j. N₂: Min - 3% by volume
   - k. O₂: Min - 10 ppm by volume

2. **Heating Value**
   - a. Higher Heating Value: Min - 1000 Btu per scf, Max - 1150 Btu per scf
   - b. Wobbe Index (HHV basis): Min - 47, Max - 52

3. **Delivery Temperatures**
   - Recipient Temperature: Min - 10°C (50°F), Max - 49°C (120°F)
# GAS SPECIFICATIONS
## NATURAL GAS COMPONENTS

<table>
<thead>
<tr>
<th>Component</th>
<th>Typical Analysis (mole %)</th>
<th>Range (mole %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>93.9</td>
<td>87.0 - 97.0</td>
</tr>
<tr>
<td>Ethane</td>
<td>4.2</td>
<td>1.5 - 9.0</td>
</tr>
<tr>
<td>Propane</td>
<td>0.3</td>
<td>0.1 - 1.5</td>
</tr>
<tr>
<td>iso - Butane</td>
<td>0.03</td>
<td>0.01 - 0.3</td>
</tr>
<tr>
<td>normal - Butane</td>
<td>0.03</td>
<td>0.01 - 0.3</td>
</tr>
<tr>
<td>iso - Pentane</td>
<td>0.01</td>
<td>trace - 0.04</td>
</tr>
<tr>
<td>normal - Pentane</td>
<td>0.01</td>
<td>trace - 0.04</td>
</tr>
<tr>
<td>Hexanes plus</td>
<td>0.01</td>
<td>trace - 0.06</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>1.0</td>
<td>0.2 - 5.5</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>0.5</td>
<td>0.05 - 1.0</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.01</td>
<td>trace - 0.1</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>trace</td>
<td>trace - 0.02</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>0.59</td>
<td>0.57 - 0.62</td>
</tr>
<tr>
<td>Gross Heating Value (MJ/m³), dry basis *</td>
<td>38.7</td>
<td>36.0 - 40.2</td>
</tr>
</tbody>
</table>
Specifications of Natural Gas

Gross Heating Value of Gas

The Gas offered at the Delivery Point shall have a Gross Heating Value in a gaseous state in the range of one thousand and fifty (1050) BTU’s per Standard Cubic Foot (approximately equal to 9,340 kilo calories per Standard Cubic Meter) to one thousand one hundred and seventy (1170) BTU’s per Standard Cubic Foot (approximately equal to 10,420 kilo calories per Standard Cubic Meter).
Typical Combustion Properties of Natural Gas

Note that there is no guarantee that the combustion properties at your location will be exactly as shown.

- Ignition Point: 564 °C *
- Flammability Limits: 4% - 15% (volume % in air) *
- Theoretical Flame Temperature (stoichiometric air/fuel ratio): 1953 °C *
- Maximum Flame Velocity: 0.36 m/s *
Specifications of Natural Gas

- **Impurities**
  
  Gas shall be reasonably free from dust (max size 5 microns), gum forming constituents and other deleterious solid and/or liquid matter which will cause damage to or interfere with the Operations of Gas Transporter’s Facilities.

- **Water Content**

  Not more than 112 Kg/MMSCM

- **Total Sulphur including H2S**

  not more than 10 ppm by weight expected H2S content not more than 4ppm by volume.
Background to the Nigerian Network Code Development

- In 2010, a network code study was carried out by consultants from the UK. This was commissioned by and overseen by the DPR. An oversight Board for the study consisted of representatives from DPR, MPR, NGC, GACN. This study was carried out with government agencies and did not formally include the private sector. The consultants delivered their study in 2011.

- This was very much based on the UK network code and there remain a number of areas in which it needs to be completed to be relevant to the Nigerian situation.
Funding

- The first network code study in 2011 was funded by the DPR. Although a DPR budget was prepared to fund implementation of the code the budget was not released to DPR and the implementation work has remained unfunded by the Nigerian Government.

- During 2016, Code were funded by the British Government, from a programme financed by DFID (Nigeria Infrastructure Advisory Facility, NIAF). The NIAF programme came to an end at the end of 2016 and the financial support also ended then. It was thought that the project could be transferred to another British government DFID programme but in the event, this did not prove possible.
Implementation Schedule:

- The Implementation Committee also agreed with the implementation schedule as drafted by the EMG consultant. Although tentative, it proposed a six month programme of work to initial launch.

Involvement of the Industry

- The Nigerian petroleum industry has been characterised to a certain extent of a gap between the public and private sectors. The network code to date has been developed within the government side of the gas industry.

- Internationally though, it is common for the industry to be closely involved in the technical development of the network code, typically through a Shippers’ Forum.
Current State of the Nigerian Gas Network Code

- The network code concept as developed in the consultancy study was closely based on the British Network Code. The draft code as presented for Nigeria is perhaps not fully relevant to Nigeria.

- The British gas network is a very complex gas network, with entry points and exit points throughout the country. The UK is one of the biggest gas markets in the world, smaller only than USA, Russia and (very recently) China, it is certainly one of if not the most complex gas market in the world.

- The complex British code includes various mechanisms which perhaps are not necessary for Nigeria (not at this stage of development in any case).
Current State of the Nigerian Gas Network Code

- The Nigerian gas network basically operates as a number of point to point systems. It may become a true network in time but for now, point to point best describes gas transportation in Nigeria.

- A network code needs to be implemented that is simple and designed for a (relatively) simple point to point system.
Scope

- It is proposed that the initial network code be made as simple and flexible as possible. The initial purpose is to introduce the concept of a network code and to get all the players used to the process.

- Develop Network Code that is more relevant to the point to point nature of the Nigerian gas system, and one which is more likely to be successfully implemented within the short term (months).

- Design simple allocation model to manage administration of shippers / suppliers, entry and exit capacities, balancing, and trading information bulletin board.
Scope

- Training in network codes
- Involve the operator (NGPTC) and Shippers-Suppliers in consultation and decision making
- Prepare an estimate of total costs for the full Network Code implementation
Conclusion

There are a lot of limiting factors in monetising and commercialising stranded gas resources

- Government need to promote market led gas development – Government is unlikely to be able to fund the required infrastructure, now or in the near future – MARKET LIBERALISATION

- Government should focus and be satisfied by providing conducive enabling environment – including developing and enforcing the Network Code

- Government take is enhanced by concentrating in collecting royalties, rent, & taxes, and provision of security
Acknowledgements:

✓ NPDC

✓ DPR, GACN, NGTPC, WAGPA

✓ OPTS

✓ Addax Petroleum

✓ NAPE