West Africa

Gas Monetisation – Challenges and Opportunities

The Royal Institution

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Agenda

- Overview of Gas Monetisation Issues in West Africa
- Consideration of specific issues in selected countries
- Potential game changers
- Conclusions

Size of circle is proportional to reported gas reserves
West Africa Gas Monetisation – The Challenges

- Superficially gas usage is full of contradictions – large gas flaring in close proximity to very low per capita commercial energy usage
- Is the biggest challenge in West Africa too much gas????????
- Or too little gas ?????????
- In fact it’s a far more complex story……..

Source: Panos London

Gas Monetisation Options

- We’ve all seen diagrams such as the following which compare distance to market versus reserves size to determine optimal monetisation routes

- West Africa has typically been an oil-oriented play with associated gas

- But such diagrams give no indication of costs ……..
Illustration of Typical Gas Development Options

- Low volume, high cost gas developments can be difficult to monetise
- West Africa characterised by numerous small fields and associated gas/gas caps. So some key options are:
  - Commercialise via Fertilizer or GTL – if gas price is low
  - Develop multiple fields and/or wait for further exploration (pre-salt?) success
  - Monetise via power generation
  - Small scale LNG?
  - Micro GTL?
- Each have challenges
Some of the issues facing gas developments in West Africa are:

- Lack of gas infrastructure
  - Lack of other infrastructure e.g. roads, ports
- Disconnect between gas availability (price and/or volume) and viable development options
- Affordability of gas in domestic markets/payment issues
- Associated gas at low pressure therefore high cost to deliver via pipeline to users
- Exports versus domestic market seeding
- Investment climate/marketing
- Numerous stakeholders and need to co-ordinate with many companies and government entities

Source: telegraph.co.uk
Production Costs and Supply Challenges

Price subsidies (e.g. power subsidies) can have major distortion effects

Prices that consumers can pay

Prices that producers require

Price subsidies
CAPEX

- CAPEX costs can be significant even for small gas volumes – and usually will be accompanied by additional location specific costs e.g. road/bridge improvements, dredging, etc.

### CAPEX for 100 MMscfd plant

<table>
<thead>
<tr>
<th>Process</th>
<th>US$MM</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTL</td>
<td>1200</td>
<td>10,000 BPD</td>
</tr>
<tr>
<td>LNG</td>
<td>1100</td>
<td>0.7 MMTep.a.</td>
</tr>
<tr>
<td>Ammonia</td>
<td>900</td>
<td>1 MMTe p.a.</td>
</tr>
<tr>
<td>Power</td>
<td>200</td>
<td>400 MW</td>
</tr>
</tbody>
</table>
Case Study – Mid Scale Gas Monetisation West Africa

- Production is widespread across country and generally flared or re-injected
- Is fertilizer production viable?
- If fertilizer production needing approximately 100 MMscf/day is targeted what needs to be done.....
Mid Scale Gas Monetisation - Key Conclusions

- Flared gas provides sufficient quantities – but gathering all is not viable (low pressure, location)
- Target of approx 100 MMscfd for commercialisation will require multiple fields
- Regional gathering viable (not country-wide gathering)
  – Current and planned field developments
- Coastal regions prioritised – exports viable
- Buy-in of government essential – to ensure adequate price and to act as gas broker
  – Will slow down and complicate the process of negotiation of a gas sales agreement but will ultimately provide more certainty
Case Study - Angola

- ALNG developed and now exporting LNG but the country faces extreme power shortages
- Are export-oriented projects “easier” than domestic market oriented ones? Large-scale gas finds may need a major export project to
  - Cover unit costs and justify upstream expenditure
  - Attract an IOC to drive the project
  - Avoid market flooding
    - E.g. if gas to ALNG were used to make ammonia this alone would supply nearly all of East African regional needs
- “Politics” of exports versus developing domestic markets
Case Study Angola – Power Generation

- Power Generation can typically tolerate high gas prices (especially if alternative is diesel generation!)
- But what if power prices in the country are desperately low? Or if massive infrastructure investment required?

![Graph showing feedstock gas price and power generation quantities]

![Graph showing power prices by country, with Angola highlighted]

Feedstock Gas Price US$/Mscf

- LNG
- GTL
- Methanol/DME
- Ammonia

Power

Small scale LNG/GTL

Quantity, MMscfd

2 4 6

Source: GCA

Source World Bank
Case Study - Angola

- However……
  - Plans to ramp-up electricity generation capacity (to 5,000 MW by 2016) and update fragmented power grid.
  - Allocation of US$17 billion from national budget – lessens the need for financing
    - Economy is buoyant and growing, thanks largely to oil and gas export revenues

- World Bank estimates of US$1.3 billion per year spending required on infrastructure….but as percentage of spend of GDP (approx 7%) this is manageable

- Gas availability for domestic power generation?
  - Various associated gas blocks supply ALNG
  - Blocks 1 and 2 – various concessions ring-fenced for ALNG future supply
    - But other concessions available for domestic market projects
Case Study - Jubilee and TEN gas monetisation

- Ghana “will not export a molecule of its gas”……..

- So a major commitment to gas infrastructure development is required…
Ghana – Targeting the Domestic Market

- Gas Processing Plant and pipeline to supply gas from Jubilee (and later TEN development) to Ghanaian market
  - Funding from China Development Bank – not likely for non-associated gas targeting domestic market
  - Delays to project from, amongst other things, payment issues

- Projected gas production from Jubilee and TEN is at levels that the domestic market can likely absorb (but will still need major investment)
  - What will be position on exports if more gas found? At what size gas discovery (if any) are exports inevitable?
Other West African Gas Monetisation Issues

▪ Nigeria
  – Largest reserves, LNG projects and export pipeline
  – But security concerns, legislative uncertainty and exit of major players
    ▪ Brass LNG – impact of ConocoPhillips country exit?
    ▪ OK LNG – BG, Shell and Chevron left project
  – Future focus on smaller scale projects driven by indigenous companies?

▪ Cameroon
  – Efforts to increase gas consumption – conversion of HFO and LFO based power generation in Douala region, plus cement manufacture and glass manufacture conversion to gas
  – Only viable due to onshore field location and low cost of gas?
Game Changers (?) – Small Scale LNG and GTL

- Small scale LNG, targeting new markets e.g. transport
  - Trucking fleets being converted to LNG in USA
  - NG Buses in China
- Some areas of west Africa have limited infrastructure – so could any new infrastructure for e.g. transport, bunkering be gas-oriented instead of traditional fuels?

- GTL – potentially convert gas to transport fuels (mainly diesel) or to syncrude and export with oil
  - Particularly applicable to associated gas fields
- May not be robust to very high gas prices (but few technologies are) – but a good match for small - mid size gas fields??
Conclusions

- Gas monetisation in West Africa is challenging but by no means impossible!
- Nothing is static – investment is occurring all the time
  - “necessity is the mother of invention” (and investment?)
- Look beyond high level data and country-wide trends
  - There doesn’t have to be a national gas strategy in order to develop one ammonia plant
  - Degree of access to electricity and length of power transmission lines installed in a country are interesting facts – but look at the specifics
- Look at whole value chain – does gas monetization plant alone need to make money or is the whole value chain more important?
- Get a good handle on regional gas balances – gas gathering schemes may not be cost effective at the moment but is anyone finding reinjection no longer viable?
- Patience is a virtue, good things come to those who wait etc. etc…..
Thank you!