Unconventional Gas: Impact on Gas Markets

Gilbert Hamaïde
Vice-President
### Unconventional resources volume is still uncertain but high

Global gas in place of unconventional gas estimated at ~920 tcm

Still a lot of uncertainties on unconventional gas resources figures, as production is still limited
- **Shale gas** production limited to North America
- **CBM** production limited to North America and Australia

### Estimation of global unconventional gas resources, Tcm

| Source: H Rogner 1997; GDF SUEZ estimates |

<table>
<thead>
<tr>
<th>Unconventional gas</th>
<th>Shale Gas</th>
<th>456 (~49%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tight-Sand Gas</td>
<td>210</td>
<td>(~23%)</td>
</tr>
<tr>
<td>Coalbed Methane</td>
<td>256</td>
<td>(~28%)</td>
</tr>
</tbody>
</table>

### Gas in place mainly localized in North America and Asia/Pacific

Breakdown of estimated unconventional gas resources per geography, Tcm

<table>
<thead>
<tr>
<th>Unconventional gas</th>
<th>North America</th>
<th>FSU</th>
<th>Middle East and Africa</th>
<th>Asia/Pacific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shale Gas</td>
<td>210</td>
<td>256</td>
<td>456</td>
<td>922</td>
</tr>
<tr>
<td>Coalbed Methane</td>
<td>256</td>
<td>210</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Tight-Sand Gas</td>
<td>274</td>
<td>155</td>
<td>36</td>
<td>127</td>
</tr>
<tr>
<td>Unconventional gas</td>
<td>274</td>
<td>155</td>
<td>36</td>
<td>127</td>
</tr>
</tbody>
</table>
## Key environmental issues

<table>
<thead>
<tr>
<th>Environmental issues</th>
<th>Description</th>
<th>Mitigation possibilities</th>
</tr>
</thead>
</table>
| Huge water needs     | • 15 to 20,000 m³ water per well | • Re-use as much water as possible  
• Diversify supply over long time-period – limit impact over other usage |
| Aquifer pollution    | • Fracking requires chemical additives: risk to contaminate aquifers  
• Variability of water recovered | • Environmental friendly fluids (water based) with chemically inert propant  
• Extra-care given during casing cementation.  
• Fracking monitored in real time (micro-seismic)  
• Robust water treatment solution |
| Footprint            | • Typical project includes hundreds of wells  
• Water storage | • Well clusters: up to 24 wells based on reservoir depth  
• Underground piping system network  
• Gas processing facilities with limited visual impact (mobile systems, biphasic transport with minimum facilities at well site…)  
• Sound-proofing walls around well site |
| Others               | • Noise during fracturing  
• Flaring when testing (visual flame and toxic emissions)  
• Visual impact | • Mobile flare system: smokeless operations with optimum burning minimizing toxic emissions and shrouded flame ensuring low noise and heat radiation  
• Use of small rigs |

COMMUNICATE & EDUCATE - GET INVOLVED IN COMMUNITY DISCUSSION
United States: Unconventional gas status

In the United States, unconventional gas: 56% of 2009 production

Shale gas: strongest growth potential in terms of production

2009 US gas production breakdown

Source: EIA
United States: Unconventional gas status

Unconventional gas costs competitive with conventional sources (most of the remaining US conventional sources are deep offshore with high exploration and development costs)

=> LNG limited to niche markets and last resort markets

[Chart showing production weighted full cycle costs by type from 2009 to 2018, with nominal dollars per Mcf on the y-axis and years on the x-axis. The chart compares associated gas, conventional, coalbed methane, tight sands, and shale.]
Reproducibility of US model success story

Unconventional gas

Tight gas
- Ongoing production in Europe/no issue of reproducibility
- Limited impact on production (no major changes—tight gas is found in conventional plays and produced after conventional resources)

Shale gas
- Plays identified and ongoing valuation of resources
- Uncertainty on reproducibility of the US model

CBM
- Unlikely to be strongly produced in Europe
  - More pregnant environmental issues,
  - More complex technical issues,
  - Poorer economics than for shale gas
Unconventional gas unlikely to be a game-changer in Europe

...but potential valuation ongoing

Rogner 1997
• GIP Europe 36 tcm: CBM (8), TG (10), SG(16)

Further research programmes ongoing to establish the evidence base
• GASH, funded by the Industry
• GeoEn, funded by the German state

---

1. 1254 Tcf Source: Cambridge Energy Research Associates, H. Rogner "An Assessment of World Hydrocarbon Resources"
Competition in Europe on shale gas

In Europe, competitors are mainly focusing on shale gas

Intense competition on land grabbing

Acreage awards and applications

- Unconv
- CBM
- Shale gas
- Tight gas

Source: IHS
Asia overview

Exporter of LNG

Australia, huge potential for CBM

Centered in Queensland and New South Wales, CBM output has grown from 1 MMcf/d in 1996 to 450 MMcf/d by end of 2008: Large potential for further growth in production: Total reserves up to 6 Tcm

CBM to LNG: Four projects to convert Queensland's CBM reserves into LNG

Potential to be in the TOP LNG exporter if all CBM to LNG projects materialize.

India, potential to be confirmed

Estimated UG reserves at 13 Tcm countrywide. Jharkhand State has largest potential at 0.7 Tcm and production already underway

Development is at its early stage

India's first CBM project started production in late 2007 and a number of uncertainties surrounds the startup of production at other CBM projects

Uncertainties/challenges

- Many uncertainties and challenges: unreliability of resources data, lack of infrastructures, expertise to develop

Importer of LNG

China, large potential for unconventional gas

CBM: Output announced goal of 10 Bcm/y in 2010 rising to 30 Bcm/y by 2015 and more than 50 Bcm/y by 2020

Funding of 17 CBM projects by the government

Tight gas and shale gas: Recent project of Shell to develop tight gas and shale gas in China

Uncertainties/challenges

- Many uncertainties and challenges: unreliability of resources data, lack of infrastructures, expertise to develop

India, huge potential for CBM

Indonesia is also producing CBM

Source: Poten

UNECE 24th November 2010
Unconventional gas impact on gas markets

- Limited development but in some countries
- Potential to be assessed

- Priority to conventional gas

- Game changer
- LNG limited to niche markets and last resort markets

- Huge potential
- Limited development during the next decade but beyond …

- CBM to LNG to materialize
- Top LNG exporter before 2020?
Thank you for your attention!