Opportunities and Challenges in the Development of Shale Gas Resources in China

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2nd Oct., 2012 - Lausanne, Switzerland
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1. Rapid Growth of Natural Gas Production and Consumption in the Past Decade

- Natural gas production: 27.2 bcm in 2000, 103 bcm in 2011, CAGR 12.9%
- Natural gas consumption: 24.5 bcm in 2000, 130.7 bcm in 2011, CAGR 16.4%
- Percentage of natural gas in primary energy consumption: 2.4% in 2000, 4.8% in 2011
2. Natural Gas Demand Increase Always Beyond Expectation

Demand Forecasting

- 2015: 260bcm
- 2020: 350-400bcm
- 2030: 500-550bcm

- Strong commitment to low carbon policy by China government
- Natural gas demand growth will mainly be driven by the utilization of residential consumption, NGV and power generation in the future

- China’s natural gas consumption mix
- Rapid growth of NGV in China
3. Majors’ Role in Domestic Gas Production

- CNPC is the main natural gas supplier, accounting for 75% of total natural gas production nationwide, and will continue to play a dominant role in the future.
4. Multi-Source Natural Gas Supply

- **Domestic gas production**
  - Gas production is expected to reach 200-250 bcm in 2020 and 250-300 bcm in 2030

- **Piped gas imports**
  - Pipelines into China from Central Asia, Russia and Myanmar
  - In 2011, China imported 15.2 bcm of natural gas
  - Imported piped gas could reach 72 bcm by 2020

- **LNG imports**
  - By the end of 2011, China had completed 5 LNG receiving terminals and another 6 are under construction, enabling China to receive more than 40 million tons of LNG each year
  - In 2011, China had already imported 12.2 million tons (17 bcm) of LNG
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1. Abundant Natural Gas Resource (Conventional and Unconventional) in China

Geological Resources

- Conventional gas: 55.9 tcm
- CBM: 36.8 tcm
- Tight gas: 25 tcm
- Shale gas: 86 tcm

Prospective resources of natural gas in China (tcm)
2. Unconventional Gas will Play a More Important Role in China

- Percentage of unconventional gas in the total natural gas production
  - 2020: ~30%
  - 2030: ~37%

The State 12th Five-Year Plan for CBM
- Incremental proved geological reserves: 1 tcm
- Total production: 30 bcm
- Surface production: 16 bcm

The State 12th Five-Year Plan for Shale Gas
- Proved geological reserves: 600 bcm
- Proved recoverable reserves: 200 bcm
- Production: 6.5 bcm
3. Different Development Stages

**Tight gas**: industrial & commercial development & utilization

**CBM**: initial stage of exploration and development

**Shale gas**: resource evaluation and pilot development
Nationwide Distribution of Tight Gas Resources

Tight gas distribution:
Sichuan, Ordos, Songliao, Bohai Bay, Tarim and Junggar

2011 production: 35 bcm
Nationwide Distribution of CBM Resources

CBM distribution:
Shanxi, Shaanxi and Liaoning

2011 surface production: 2.3 bcm, ↑ 54.7%
Distribution of Shale Gas Resources

Shale gas distribution: South, Northwest, North China, Northeast, Qinghai-Tibet

Operation activities focus on Sichuan basin, Ordors basin and East Liaohe
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1. Resource Evaluation of Shale Gas

- Different agents provided different evaluation results
- China’s shale gas resources are relatively abundant

<table>
<thead>
<tr>
<th>Agent</th>
<th>Resource, tcm</th>
<th>Resource Type</th>
<th>Time</th>
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<tr>
<td>IHS</td>
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<td>Geological resource</td>
<td>2008</td>
</tr>
<tr>
<td>RIPED(CNPC)</td>
<td>86-166</td>
<td>Geological resource</td>
<td>2009</td>
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<tr>
<td>EIA</td>
<td>36.4</td>
<td>Recoverable resource</td>
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<td>Ministry of Land and Resources (China)</td>
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<td>Recoverable resource</td>
<td>2012</td>
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</table>
2. Shale Gas: A New Gold Rush?

Central Government
• New category of mineral
• The 12th Five-Year Plan

Academy & Media
- Forum
- Conference
- Summit
- Seminar
- Workshop

Local governments
A number of joint companies have been established to march towards the shale gas development in some provinces such as Hunan, Henan, Sichuan, Chongqing, Xinjiang, Shanxi, etc.

Investment & Market
- The first round of public bidding for shale gas exploration and drilling rights: 6 participants
- The second round: >100 companies
- International oil companies such as Shell, Chevron have begun their E&P in China
- Shale gas has become a hot concept or new board in the capital market

2012.5.9 The 8th China Energy Investment Forum, Beijing
2012.8.29 China Unconventional Gas Summit 2012, Beijing
2012.9.5 2012 China International Unconventional Oil & Gas Summit, Zhengzhou
2012.9.12 2012 China Karamay International Unconventional Oil & Gas Forum, Karamay
2012.9.24 The Second International Unconventional Oil & Gas Resources Conference, Taiyuan
2012.11.5 The Third Asia Unconventional Gas Summit, Beijing
2012.11.8 2012 Unconventional Gas International Forum, Ningbo
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3. Achievements of Shale Gas Development

- The pilot exploitation focuses on Sichuan, Ordos, Bohai Bay basin, etc.
- Sixty-one wells have been drilled, of which twenty-one wells have gas show. The output of vertical wells is $0.1-2 \times 10^4 m^3/d$, and horizontal wells $1-15 \times 10^4 m^3/d$.
- CNPC has selected four favorable areas, Weiyuan, Changning, Zhaotong, Fushun-Yongchuan in South Sichuan and North Guizhou, to implement the company’s shale gas development plan.
4. Challenges in Shale Gas Development

(1) Complicated Shale Gas Reservoir

- **China shale reservoir**
  - Marine shale in early Paleozoic
  - Ro: 1.1%-4.6%, relatively small region of buried depth shallower than 3000m
  - Complicated terrain

- **U.S shale reservoir**
  - Marine shale in late Paleozoic
  - Ro: 0.4% - 2.5%, buried depth: 1000-3500m
  - Simple structure and flat land

<table>
<thead>
<tr>
<th>Region</th>
<th>Era</th>
<th>Facies</th>
<th>TOC (%)</th>
<th>Ro (%)</th>
<th>Brittleness (%)</th>
<th>Buried Depth (m)</th>
<th>Preservation</th>
<th>Surface</th>
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<tr>
<td>U.S.</td>
<td>D,C</td>
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<td>1000-3500</td>
<td>Stable, Gentle</td>
<td>Flat</td>
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<tr>
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<td>37-80</td>
<td>1500-4000</td>
<td>Fault</td>
<td>Mountain</td>
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(2) Lack of Suitable and Effective E&P Technologies

- China has to introduce most of the core technologies and key equipment from abroad to overcome the difficulties in the shale gas exploration and development.
  - Suitability?
  - Cost?
3) Dilemma: Water Resources and Environmental Protection

- Where abundant water supply, where high population density
- Where low population density, where water scarcity
Most shale gas plays are located in developing or undeveloped areas, where the existing infrastructure and pipeline cannot meet the demand of large-scale development.
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1. The Future of China’s Shale Gas Development is Bright with Twisting Road

- Abundant shale gas resources and successful pilot exploitation strengthen our confidence. But there is still a long way to go to achieve large-scale commercial development. It’s hard to imagine that China could simply repeat the success of the North American shale gas development.

2. China’s Shale Gas Development Depends on Technology Innovation

- The North American shale gas revolution is driven by technology innovation, especially horizontal drilling and multi-stage hydraulic frac. China is speeding R&D in unconventional gas and dedicated to the integrated efficient and suitable technology solution, which will determine the prospect of China’s shale gas development.
3. China’s Shale as Market will be More Open and Flexible

- Now, China’s shale gas market participants are not only majors such as CNPC and Sinopec, but also many small companies. More and more private funds have been involved in shale gas industry encouraged by the market open policy. Undoubtedly, players in the shale gas market will be much more diversified and the operational mechanism more flexible.

4. China will Adhere to the Principle of Priority of Environmental Protection

- China has paid great attention to the environmental problems in shale gas development, especially water pollution, vegetation destruction and earthquake. Related regulations are being legislated and supervision strengthened to achieve the harmonious and green development.
THANK YOU!