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By
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The Emerging Petroleum and Natural Gas Economy

30 SEP 2009

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ABSTRACT

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The Emerging Petroleum and Natural Gas Economy

Ft. McNair, Washington, D.C.

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Sept 30, 2009
Topical Focus

• Peak Oil
• Technology Developments
• NOCs & IOCs
• Game Changers
  • Climate
  • Natural Gas
Beyond Peak Oil: Global Resource Endowment is enormous, but conventional distribution is uneven and unconventional resources have environmental challenges.
Geopolitical & governance risks are accumulating

- **Canada:** Climate policy
- **US:** Climate Policy, access, storms
- **Europe:** Gas Supplies
- **Caspian:** Transit Security
- **Russia:** Policy
- **Iran:** Nuclear Ambition
- **Iraq:** Instability
- **Pakistan:** Political Turmoil
- **Nigeria:** Civil Unrest
- **Aden, Malacca:** Piracy
- **China:** Demand increase
- **N-Korea:** Nuclear Ambition
- **Latin America:** Resource Nationalism

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Non-OPEC Oil Production Looks Flat

(change from previous year)

Million barrels per day

2010
2009
2008

Source: EIA, STEO September 2009
OPEC Surplus Production Capacity

Total Current (est.): 5.5 mmb/d

Note: Shaded area represents 1998-2008 average (2.8 million barrels per day)

Source: EIA STEO September 2009, Bloomberg, IEA OMR
Replacing Global Liquids Supply Will Be Challenging

Source: CSIS, EIA
15 of the Top 20 Largest Oil Companies are NOCs; NOCs control 80-90% of conventional oil and gas reserves; Will play an increasing role in managing resources going forward.

Sources: PFC Energy, HFHS
All NOCs are NOT alike, but they share certain priorities and objectives:

- Agents of host governments
- Protectors of the National Resource Patrimony
- Source of Revenues needed to fund other programs
- Responsible for Social development & infrastructure
- Role in International relations
- Stakeholders are Political
- Management practices, operating standards and agendas different from IOCs
A Word on Technology Advancements

- Better diagnostics, intelligent wells
- GeoSteering
- Improved reservoir simulation
- Pre-salt experience
- Maximum Reservoir Contact Wells
- Sub-sea completions
- Rez “Bots”
- Horizontal drilling (shales)

**Bottom Line:** Significant new discoveries (BB fields), improved accessibility & increased recovery rates
Game Changers

• Climate Change and Regulation of Carbon & GHG Emissions

• Exploitation of Unconventional Shale Gas Reserves
Climate Change as a Game Changer

• Affects supply & demand
• Alters fuels choices, increases prices
• In the extreme, raises security concerns
• New investment & technologies applied on a global scale
• Implications of a fractured vs. unified response
• Concept of “Sustainable Development” challenges traditional view of economic prosperity
• Requires long-term global policy solutions and trade-offs balances
Climate Change as a Threat Multiplier
Conventional Global Natural Gas Reserves

Source: BP Statistical Review 2009
Global Gas Supply Dilemma

• Global gas demand to grow, especially in a carbon constrained world
• Conventional supply sources become more concentrated geographically
• Concentration can affect leverage, supply and prices, geopolitics, etc.
• Delivery system under greater stress
• Price rise + increased import dependence recreates balance of payments concerns
What’s New?: Substantial growth in U.S. natural gas production through 2030 led by unconventionals…

Source: EIA Annual Energy Outlook 2009
Conventional vs. Continuous Resources
Game-Changing Potential: Estimates of US Shale Gas Resources

**EIA Annual Energy Outlook 2009:** 267 tcf undiscovered technically recoverable shale gas resources (mean)
  • Based on 2007 U.S. Geological Survey assessment and 2006 Mineral Management Service data

**Navigant Consulting Inc. 2008:** 274 tcf undiscovered technically recoverable shale gas resources (mean)
  • Based on aggregated data from numerous studies

**Navigant Producer Reports 2008:** up to 842 tcf undiscovered technically recoverable shale gas resources (max reported)
  • Ascertained by Navigant in 2008 study (accounts for Marcellus and Haynesville)

**Potential Gas Committee 2009:** 616 tcf undiscovered technically recoverable shale gas resources (mean)
  • **Estimated total U.S. gas resources** of 2,074 tcf (mean undiscovered tech recoverable + reserves)
Shale Resources and Natural Gas Pipeline Network

Source: R Hefner
New US Domestic resources mean less imports (pipeline gas and LNG) and more supply choices for the world!

<table>
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<th>Year</th>
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<th>Projections</th>
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<td>1990</td>
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<td>2030</td>
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Source: EIA Annual Energy Outlook 2009
Implications of Global Shale Gas Exploitation

- Development of US shale formations would free up LNG for use elsewhere
- Significant shale prospects likely in China, Turkey, Australia and Europe
- Development of indigenous gas sources, coupled with LNG, efficiency, renewables and interconnects could reduce EU reliance on Russian gas
- Global gas surplus could revamp price/contract structures
Source: The Economist
BUT …realizing the full promise of shale resources is not a certainty and US domestic policy is important!

Technical/Economic Challenges

- All shales are not alike; application of drilling/reservoir fracturing technology & operational experience matters
- Steep decline rates require ongoing investment and drilling; and repeated fracturing
- Up front investment (lease acreage and pilot wells) not insignificant vs. cost basis relative to commodity price/value

Environmental/Regulatory/Societal Challenges

- Uncertain regulation (hydraulic fracturing, water, land use, permits), “industrialization” of areas unfamiliar with development plans and associated impacts
- Location, location, location – shale resources are, at times, proximate to and distant from delivery infrastructure and demand centers – both present problems
Strategies to Enhance Oil U.S. Security Count

Source: EIA Reference Case / NPC Global Oil and Gas study survey.
Policy Model

- **Economic Objectives**
  - Affordable/Accessible
  - Reliable and Secure

- **Environmental Objectives**
  - Low/no emissions
  - Environmentally Benign

- **Security & Foreign Policy Objectives**
  - Defensible
  - Supports Economic Growth & Employment

- **Energy Sources**
  - Natural Gas
  - Oil
  - Nuclear
  - Coal
  - Renewable Energy
  - Carbon Capture and Storage

- **Energy Efficiency**