Perspective on Energy Business Challenges
In the “Age of Energy Supply Anxiety”

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E&P Landscape
“Age of Energy Supply Anxiety”

- Demand + supply constraints + uncertainties = high prices
  - Global scramble to control oil & gas resources
- Soaring costs
  - Shortages of equipment, services & trained personnel
  - Technology imperative – improve recoveries & efficiencies spanning supply chain
- Changing competitive landscape - “resource nationalism”
  - Increasing state control of resources
  - Heightened geopolitical risks
- Growing conflict between “Energy Security” and “Environment / Climate Change” policies
Energy Policy Challenges

• Energy Security
  
  Supply energy to fuel global economic growth
  
  • High economic growth rates
    • OECD = 2.5%
    • Non-OECD = 5.3%
  
  • Expanding middle classes – India, China = expanding demand
  
  • Integration of global economies

• Environment / Climate Change
  
  Manage consequences of energy use
  
  • Mitigate local and regional environmental impacts
  
  • Manage global carbon build-up in the atmosphere
Energy Demand Challenges
Global Sources for Energy Supplies

EIA energy growth:
2004 – 2030 = 57%

CERA “Dawn of New Age”
2004 – 2030 = 75%

Asia = 50% oil demand
75% power demand

Energy Industry Challenges
Managing Global CO2 Emissions

Solutions
• Energy efficiencies
• R&D – innovative technologies and commercialization:
• Carbon capture & storage

Objectives

• Outline challenges to transform global O&G resources to supplies

• Frame US energy vs climate issues

• Outline impacts of challenges on industry business practices and technologies
Challenges in Transforming Oil & Gas Resources to Supplies
Challenge #1: Elevated Political Risks & Uncertainties

“Chavezism”
Quasi-Nationalism
Nationalize the Faja

Civil Unrest

Terrorist Threats
662 Bbo

Shtokman

“Putinism”
Sakhalin 2
Challenge # 2: Increasing State Control: Escalating Fiscal Terms
Challenge #2 Increasing State control
Escalating Fiscal Terms (2002-2007)

Before
After
Challenge #2: Increasing State Control
International NOC Expansion – Chinese

Chinese: trade $$, technology and infrastructure for energy supplies. E&P partnership with India.
Challenge #3 - Soaring Costs
Shortages of Materials & Personnel
IHS/CERA Upstream Capital Cost Index (UCCI)

Index (2000=100)
Challenge #4
Environmental Regulations & Climate Change Policies

Representative John Dingell (Chmn. House Energy Committee)
“The issue of global climate change and its effect on our national energy policies is critical.”

Action: Propose to reverse most of the energy development incentives in the 2005 Energy Bill.

“Properly addressing climate change requires us to address the issue of consumption. We do that by making consumption more expensive.”

Action: Propose carbon taxes, gasoline taxes and eliminate mortgage deduction on large homes.
“Three pillars for future liquids resources”

1. Field growth
2. Unconventional resources
3. Yet to find

“Building Blocks to Estimate O&G Resources”
Challenge # 5 Resources Replacement
Resources & Discoveries 1900-2006

Number of Discoveries

Gas
Liquids

North Field / South Pars
Urengoy
Marun
Astrakhan
Akhaz
Burgan
Ghawar
Gachsaran
Kashagan

Million Barrels Oil Equivalent

Discoveries in Period

Discoveries & Field Growth 2004-2006

Resource growth & revisions to large fields discovered prior to 1981 added 348 Bbo from 1996 to 2006.

Boosting RF from 34% to 47% could add as much new liquids as consumed to date!
Challenge # 5: Reserves Replacement
Unconventional Liquids Resource Plays

In-place resources are three times greater than the 2,330 billion barrels of recoverable resources of conventional oil discovered to date.

Distribution of Initial In-Place Resources of Major Non-Conventional Sources of Liquid Hydrocarbons (billion barrels)

- Venezuela Orinoco Oil Belt: 750 (high-end: 1,900)
- Other Extra-Heavy Oil: 500
- Canada Oil Sands: 1,700 (high-end: 2,500)
- Other Bitumen: 1,300
- USA Shale Oil: 2,100
- Other Shale Oil: 300

Figure 1
Canadian Oil Sands Map

* Estimated Oil in Place P1+P2

- **Peace River**
  - 100 billion bbls*

- **Athabasca**
  - 1,400 billion bbls*

- **Cold Lake**
  - 200 billion bbls*

**Source:** CERA
Challenge # 5: Reserves Replacement
Unconventional: Canada Oil Sands - Bitumen - Production

Canadian Bitumen / SCO Production Forecasts to 2015

- Production to Date plus IHSE Unrisked Forecast (Jun 2007)
- NEB Year 2006 Base Case Forecast (WTI = US$50 / C$59)
- NEB Year 2004 Mid-Range Forecast (WTI = US$24 / C$32)

200,000 barrels / day of new production / year

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# Canadian Oil Sand Projects

## Capital Cost Creep

<table>
<thead>
<tr>
<th>Project</th>
<th>Operator</th>
<th>Start up</th>
<th>Orig Cost $ Billion</th>
<th>Current Est Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millennium</td>
<td>Suncor</td>
<td>2002</td>
<td>$3.5</td>
<td>70%</td>
</tr>
<tr>
<td>Albian</td>
<td>Shell</td>
<td>2003</td>
<td>$5.7</td>
<td>60%</td>
</tr>
<tr>
<td>Phase 3</td>
<td>Syncrude</td>
<td>2006</td>
<td>$8.6</td>
<td>100%</td>
</tr>
<tr>
<td>AOSP Expan 1</td>
<td>Shell</td>
<td>2010</td>
<td>$11.0</td>
<td>60%</td>
</tr>
<tr>
<td>Long Lake</td>
<td>OPTI-Nexen</td>
<td>2007</td>
<td>$4.6</td>
<td>25%</td>
</tr>
<tr>
<td>Horizon</td>
<td>CNRL</td>
<td>2008</td>
<td>$7.6</td>
<td>12%</td>
</tr>
</tbody>
</table>
## Canadian Oil Sands Operational Efficiencies- Thermal

<table>
<thead>
<tr>
<th>Energy Users</th>
<th>2000</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery Factors</td>
<td>13 %</td>
<td>40%/80%</td>
</tr>
<tr>
<td>Water usage</td>
<td>3-4 bl/bl bitumen</td>
<td>1/4 bl/bl bitumen</td>
</tr>
<tr>
<td>Gas usage</td>
<td>0.6 Mcf/bl</td>
<td>0.47 Mcf/bl</td>
</tr>
<tr>
<td>Steam: oil ratio</td>
<td>4.0 - 3.5</td>
<td>3.5 - 2</td>
</tr>
<tr>
<td>Emissions</td>
<td></td>
<td>-45%/ 90% NG</td>
</tr>
</tbody>
</table>
Canada
Above Ground Challenges

• Nexen Long Lake heavy oil project delayed. Capital costs increase 15% from initial $5.3 Billion. Extreme skilled labor shortages to complete production and upgrading infrastructure.

• Canadian Royalty Review Board:
  • Months of uncertainly awaiting proposed tax and regulatory revisions for greenhouse gasses.
  • Canada 2007 drilling down 35% from 2006.
  • GHG emission problem: (Kyoto)
    • Pledged 6% reduction from 1990 by 2012
    • Current 27% increase from 1990
    • Propose 18% reduction from 2006 base by 2010; 2% annual thereafter
    • Oil sands reduce emissions per barrel by 42% since 1990 but increased production by 4X
  • CNR to cancel 425,000 b/d oil sands development and reduce gas drilling 65% if proposed tax increases are implemented
U.S. Natural Gas
Substantial increases in non-conventional gas drilling unable to offset conventional gas declines

Gas Wells

Offshore  Onshore Assoc  Onshore Conventional  Tight Sands  CBM  Fractured Shale
Vintage Gas Production Profile
U.S. Lower 48 States: 1995 - 2006

2002 base decline = 2.53 Tcf
Need > 24,000 gas wells to maintain production

Well average production profile
~ - 500 Mcfd
US Vintaged Daily Gas Production Contribution to January 2006 Volume

MMcfd

0 10000 20000 30000 40000 50000 60000

1989 1991 1993 1995 1997 1999 2001 2003 2005

Gas Prod

50%

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The Key to Unconventional Gas Growth: Increasing Well Density in Lower 48 Hotspots

- **Wattenburg**: 40 to 20 acre
- **Pinedale**: 40 to 20 and 10 acre in several Lance units
- **Piceance**: 40 to 20 to 10 acre
- **Natural Buttes**: 80 to 40 acre and 20 acre
- **Jonah**: 20 to 10 and awaiting 5 acre
- **San Juan Coal Seam**: 160 to 80 acre
- **Sahara**: to 40 acre
- **Fayetteville Shale**: 80 to 25 acre
- **Cotton Valley**: 80 to 40 acre
- **Coal Seam**: 60 to 30 acre
- **Barnett Core area**: 40 to 20 acre 10 acre pilot
- **Bossier Deep**: 160 acre

Tight Sand – Basin Centered Gas Plays
Increased Density & Surface Disturbance

160 Acre Surface Density

Solutions:
- Drill from pads
- Pipe water
- Seasonal activity
- Community relations

20 Acre Surface Density

Characteristics:
- Porosity < 13%
- Permeability 0.001-1.0 md
- Recovery ~ 10%
Anti-Hydrocarbon Challenge
The Perfect Storm

Source: COGA Americans for American Energy
Energy Security vs Climate Security
Oil Shale Outcrop: Roan Cliffs, Rifle, Colorado

Colorado has all, or parts, of seven of the top 50 natural gas fields in the nation!

Four of the top 50 gas fields in the United States are located along I-70 below the Roan Cliffs

Source: Mathews, Colo. Geol Survey

240 Bbo in place

The Mahogany Zone in the Roan Cliffs above Rifle, CO.
Gas Development Issues
Roan Plateau, Colorado

• BLM approves strict development rules on 70% of the 73,602 acre Roan Resource Management Plan area.
• Limits drill activity to ridges; pads > ½ mile separation; maximum 250 acres (~ 0.6% of area) active at any time
• Reduces development of 6-7 Tcf of recoverable gas with potential 6 billion revenue to CO over 30 years.

Reactions:
• Senator Salazar: 120 day moratorium for CO to respond
• Gov. Ritter: Voiced deep reservations to drilling on the plateau
• Rep. Udall: Legislation to ban rigs from the plateau
• Rep. DeGette: Bill to designate Roan Plateau as Wilderness Area
New Operating Practices
Fulfilling the Social – Environmental “License”

Wildlife Habitat

Pallets Minimize Surface disturbance

Operate in Subdivisions and Crops

Effective Reclamation

Source: Noble energy

Source: Questar
New Operating Practices
Efficiencies – Environment - Costs

Liquids Gathering Systems
- Source: Questar
- Source: Pioneer

Produced Water Treatment
- Water Quality In = 2000 mg/l
- Federal Drinking Water Standard = 500 mg/l
- Water Quality Out = 460 mg/l
- Perrier = 480 mg/l

Note: Water meets all other surface discharge permit requirements untested

Fit for Purpose Rigs
- Source: EnCana

Economies of Scale
- Frac Hubs
- Source: EnCana
The Digital Oil Field of the Future (DOFF)

Integrated Field Planning
- Total asset awareness
- Right-time analysis & decision-making
- Timely execution

Remote Project Management
- People
- Process
- Technology

Results
- Increased reservoir recovery
- Increased production rates
  - Better well performance
  - Reduced downtime
- Lower operating costs
Field Case Study: Shallow-water Oil

Upgrade Brownfield Activities

Assetwide Optimization Model

Well Instrumentation
- outfitted w/ quartz P&T sensors
- outfitted w/ fiber DTS sensors
- downhole flow control in injectors

Permanent Seismic Grid

Fiber Link

Move IT architecture onshore

Reduce offshore staffing

Onshore Operations Centers
(operations & drilling)

3rd-party Equipment Performance Monitoring

- Increased reservoir recovery: 4-6% OOIP
  - 4D seismic, improved injection programs, better zonal production allocation
- Increased production rates: 8-10%
  - faster well start-ups, system-wide optimization, improved maintenance
- Lower operating costs
Field Case Study:

• Integrated Field Planning (IFP)
  • Improve on-time project completion rates 30% to 90%

• Align and simplify organization with IFP and efficiencies of centralized operations centers
  • Lower capex by 5% (workforce productivity)

• Embrace continuous improvement mentality
Concluding Comments

• The World is not running out of oil & gas resources
  • Hydrocarbons continue to be critical to meet energy demand
  • Industry shift to unconventional and brownfield & frontier resources to increase supplies
• Increased state control limits IOC access to resources
• Cost increases, shift to unconventional resources and climate change policies are three prime drivers of changes in technologies, business processes and strategies
• Companies adopt collaborative approaches to resolve community & environmental concerns while delivering O&G supplies through efficient manufacturing-like processes.
• Confrontation between environmental / climate change policies and energy security may intensify through the balance of this decade
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