The Importance of Unconventional Gas in North America’s Energy Supply

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AJM Petroleum Consultants
14th March 2005
SPWLA Unconventional Reservoirs Symposium, Kananaskis, Alberta, Canada
The Current Reality

- World fixation on oil price
  - Close to World oil peak?

- North America’s situation more critical
  - Reached(?) natural gas peak production

- Canada: the ‘swing producer’ for North American gas for the past decade

- Peak of Alberta gas portends peak in Canadian and North American gas production

- Flat or Declining gas production
  - good news for Unconventional gas
  - bad news for consumer and economy of North America
North American Oil Production

Source: BP, 2004
North American Oil Production + Imports

Import Growth after peak responsible for World instability
North American Natural Gas Production

Source: BP, 2004 and others
North American Natural Gas Production + Imports

Production Bcf/d

- LNG
- Mexico
- Canada
- USA CBM
- USA Other Unconv
- USA Conventional

$<$2.00 $>$5.00

LNG 2 Bcf/d
North American Natural Gas Production

- Trend lags oil by about 30 Years
- Demand increasing at same time that production is declining
- Solutions:
  - Consume less
  - Promote energy alternatives
  - Import more Natural Gas (LNG)
  - Unconventional Gas
- All four will become vital to sustain the North American economy
- What can Canada deliver?
Canada:

- 3rd Largest Natural Gas Producer
- 2nd Largest Natural Gas Exporter
- 1% of World Natural Gas Reserves
- ~20% of World Drilling Rig Count
Canada’s Natural Gas Production
(Bcf/d Adapted from CAPP Data)

Production Growth controlled by pipeline capacity

>50% of Canada’s production is exported to USA
Alberta New Gas Drilling and Daily Sales Gas (CAPP Data)

High activity, high price and declining production = Red Flag
Canada’s Natural Gas Resources and Reserves
Resource Triangle

Conventional Reservoirs

Obvious Traps

Small Resource
High Quality
Difficult to find
Low cost
High margin

Unconventional Reservoirs

Oil Shale
Shale Gas
Gas Hydrates

W.C.S.B.

Basin Maturity
Better Technology (Higher prices)

Low cost
High margin

Large Resource
Low Quality
Easy to find
High cost
Low margin
Canada’s Resources and Reserves
Natural Gas (Conventional data adapted from CGPC 2001)

°1000’sTcf

Ultimate
Resources

Total
Conventional + Unconventional
592Tcf

Discovered
340Tcf

Raw Gas
204Tcf

Sales Gas

Remaining
Reserves

Unproduced

58 Tcf
(>95% WCSB)

Rate of Conversion:
Accessibility
Technology
Price
Motivation
‘Orphaned’ Conventional Resources (Skipper, 2001)

Green-Amber-Red Resource Assessment

Canadian Shield
Understanding Remaining Gas Resources – Accessible and Economically Available

<table>
<thead>
<tr>
<th>Available at current prices</th>
<th>Accessible</th>
<th>Accessible with restrictions</th>
<th>Inaccessible</th>
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<tbody>
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<td>Unavailable Resources</td>
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Available at higher prices

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Can apply this approach to Conventional and Unconventional Resources

Russum, CSEG Recorder, June 2003
World Gas Reserves
(BP, 2004)

Total 6206 Tcf

Canada: 1% of Reserves
North America: 4% of Reserves
29% of Production
30% of Consumption

Currently a landlocked resource, LNG could make gas a world commodity
Reserves to Production R/P or RLI

- Total World: 67.1 Years
  - Russia 81.2 Years
  - USA 9.5 Years
  - Canada 9.2 Years
  - UK 6.2 Years (Peaked in 2000)

- Alberta’s R/P: 7.5 (28 in 1982)

- Does not mean we will run out of gas in 7.5 years!!
  - Cannot sustain production rate as reserves decline
Reserve Replacement Cost 2002

$US/BOE (Adapted from: John S. Herold / Harrison Lovegrove & Co.)
“Don’t worry - Canada is less explored than the US”

- We have fewer Basins
- Every Basin and geologic trend has different potential
- The WCSB has been more efficiently exploited than any other Basin in the World
- Some of early ‘Unconventional’ knowledge evolved in Canada (Deep Basin=BCG, Shallow biogenic gas)

Should not assume we will see the same trends in Canada as have occurred in the USA
Predicting the Future

Dave Russum
Geo-Help Inc
June 2003
Natural Gas In Canada – Where are we going?

GLOBAL FUTURE?
- Kyoto?
- El Nino?
- NAFTA?
- OPEC?
- LNG?
- Politics?
- Terrorism?
- N.Am Economy?
- Energy alternatives?

SUPPLY: Exploration Remaining Reserves

DEMAND: Production Exports

↑ Prices

Time →

Prices
Resource Development Model (RDM) – 8 Stages

- Discovery
- Evaluation
- Development
- Growth
- Peak
- Decline
- Reality
- Abandonment

Knowing current stage of project can better predict future
## Canada’s Hydrocarbon Stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>1 Disc</th>
<th>2 Eval</th>
<th>3 Dev</th>
<th>4 Grow</th>
<th>5 Peak</th>
<th>6 Dec</th>
<th>7 Real</th>
<th>8 Abn</th>
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<tbody>
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<td>AB Gas</td>
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<td>Mackenzie Gas</td>
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<td>Shale Gas</td>
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<td>AB Oil - Light</td>
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<td>AB Oil - Heavy</td>
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<td>Tar sands - surface</td>
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<td>Tar sands – in situ</td>
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Predicting the future

Resource Development Model
+ Current Production*
+ Decline Analysis*
+ Investment/Exploration/Drilling/Technology trends
= Accurate prediction of future production

* Data from PetroCube a new product from AJM Petroleum Consultants
Future Conventional Marketable Gas Prediction (Bcf/Yr)

Dave Russum, 2003
Future Marketable Gas Prediction (Bcf/Yr) Including Unconventional

Assume:
1Bcf/d by 2009
(10,000 successful Wells)
2.2Bcf/d 2016

NEB 2003 Expectation +5.5Bcf/d

Dave Russum, 2003
Unconventional Gas

‘More Challenging to extract’:

- Low permeability
- Low productivity, often low decline rates
- Source rock and reservoir closely related
- Large resources, recovery factors low
- Require greater drilling density
- Environmental issues
- Area and resource specific solutions
- Low risk once specific solutions identified
- Relatively high cost
Types of Unconventional Gas

- Shallow Biogenic Gas
- ‘Tight’ Gas (includes Deep Basin and BCG)
- Coalbed Methane (Natural Gas from Coal)
- Shale Gas
- Gas Hydrates
- Inorganic Methane
## Unconventional Gas Opportunities

<table>
<thead>
<tr>
<th></th>
<th>Status USA</th>
<th>Resource in Canada</th>
<th>Status Canada</th>
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</thead>
<tbody>
<tr>
<td>Shallow Biogenic Gas</td>
<td>On-going Production</td>
<td>Large</td>
<td>Production since 1905</td>
</tr>
<tr>
<td>Tight Gas</td>
<td>Growth Opportunity</td>
<td>Large</td>
<td>Production since 1976</td>
</tr>
<tr>
<td>Coalbed Methane</td>
<td>On-going Production</td>
<td>Large</td>
<td>Production since 2002</td>
</tr>
<tr>
<td>Shale Gas</td>
<td>On-going Production</td>
<td>Large?</td>
<td>Experimental activity</td>
</tr>
<tr>
<td>Gas Hydrates</td>
<td>Experimental Research</td>
<td>Very Large</td>
<td>Experimental Research</td>
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<tr>
<td>Inorganic Gas</td>
<td>?Theoretical</td>
<td>?</td>
<td>?Theoretical</td>
</tr>
</tbody>
</table>
Canada’s CBM Opportunities

- Significant coal bearing basins from Vancouver Island to Nova Scotia

- Best opportunities in WCSB especially where infrastructure available and environment familiar with gas activity

- 4 primary coal intervals identified:
  - Ardley Coals, Scollard Formation, Upper Cretaceous/Tertiary
  - Horseshoe Canyon Coals, Edmonton Group/Belly River Group, Upper Cretaceous
  - Mannville Coals, Lower Cretaceous
  - Kootenay Coals, Lower Cretaceous/Upper Jurassic

- Major challenge is finding sufficient permeability
## WCSB Coalbed Methane

<table>
<thead>
<tr>
<th></th>
<th>Resource Potential</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ardley Coal WC Alberta</td>
<td>Low/Moderate</td>
<td>Limited activity, Best potential is relatively remote</td>
</tr>
<tr>
<td>Horseshoe Canyon Coal</td>
<td>High</td>
<td>Focus of current activity, readily accessible, dry gas</td>
</tr>
<tr>
<td>Mannville Coal WC Alberta</td>
<td>Very High</td>
<td>Experimental activity, requires de-watering eg. Trident, Corbert Creek.</td>
</tr>
<tr>
<td>Mannville Coal NE BC</td>
<td>Moderate?</td>
<td>Experimental activity, - 7 permits granted, confidential results</td>
</tr>
<tr>
<td>Kootenay Coal SE BC</td>
<td>Moderate</td>
<td>Experimental, Encana, Devon. Coal continuity and environmental problems</td>
</tr>
</tbody>
</table>
Horseshoe Canyon wells - on production date
(Non confidential wells as of November 2004)
Horseshoe Canyon CBM Production

CBM producing well count: 1061, Water <2bbls/Mmcf
Mannville CBM Production
AJM Database wells producing Dec 2004

CBM producing well count: 59, Water >3000 bbls/Mmcf
Our Challenges in Canada:

- ‘Just in time’ Industry focused on short-term results
- We have become risk averse
- Not investing in enough research for exploration and extraction
- Escalating COF&D
- Governments have taken a hands-off approach to energy (no overall energy management or plan)
- Obligations to Kyoto and NAFTA
- Increased demand for energy to extract oil
The Challenge for North America

- Promote Unconventional resources, alternative energy sources and energy conservation

OR

- Place our energy destiny in the hands of foreign countries by accepting LNG as the solution
Summary

- Canada (North America) is not running out of gas resources
- Rapidly depleting our accessible, low cost gas reserves
- Alternatives exist – take research, time and money
- We need to be very conscious of costs and economic viability in relation to a North American and World market
- The need for Unconventional gas will be huge – at the right price!
Welcome your feedback

Contact Dave Russum
Email: daver@ajma.net

More Information:
www.ajma.net

Thank You