Canadian Tight Gas:  
Developing and Applying  
a Workable Definition

Bob Dixon and Dave Flint  
November 15, 2007

Western Canada Tight Gas Resource  
Characterization Project

Natural Resources Canada - GSC
Devon Canada Corporation
Husky Oil Operations Ltd.
Imperial Oil Limited
Petrel Robertson Consulting Ltd.
Talisman Energy Inc.
TransCanada Pipelines Limited

NEB, CGPC, BCMEMPR, EUB, Sask IR, ARI, USGS, EIA

November 2007
Outline

- Introduction
- Tight Gas in USA/Canada
- Definitional Issues
- 0.1 mD Myth
- Adopted Definition
- Application of Definition

Unconventional Gas is Largest Source in the US

Natural Gas Production by Source, 1990-2030

Largest single source of supply since 2000
Unconventional Natural Gas Production by Type 1990-2030

Tight Formation Gas is Largest Unconventional Type

- History
- Projections

Tight sands
Coalbed methane
Gas shales

EIA AEO 2007

Largest single source of supply since 2005

Tight Gas in Western Canada

Tight gas is an expression widely used by:
- Publicly-traded firms to describe plays and activity in financial disclosure
- Technical associations, professionals and academics
- Journalists in trade publications
- Government agencies (rarely)

According to these sources:
- Tight gas is developed and producing in Western Canada
- The undeveloped resource base is believed to be large
- Supply from tight gas will increase as industry learns to develop and apply appropriate technology

High expectations
Tight Gas Not Reported in Canada

- Tight formation gas is not defined and distinguished from "conventional"
- Current tight gas production and size of future opportunity remain uncertain
- Geographic and stratigraphic distribution and reservoir characterization of tight gas plays not available in public reports
- Tight gas resource potential not included in CGPC, federal or provincial agency estimates
- Supply potential and opportunities to increase tight gas supply not founded on consistent definition, play characterization and resource estimates

GIP estimates up to 1500 Tcf in the early 1980s
Is the resource really there?

Gas Production Profiles

US Lower 48 Gas Production, by Resource Type
- Conventional gas in decline
- Tight gas in lower 48 over 30% of 2005 total
- CBM and shale gas significant

Western Canada
- CBM growing rapidly
- Tight gas not reported
  - estimate over 30% of 2005 total
- Conventional gas in decline

Better understanding of tight gas is important
## Different Resource Models

<table>
<thead>
<tr>
<th>CONVENTIONAL</th>
<th>UNCONVENTIONAL</th>
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<tbody>
<tr>
<td>1. Discrete gas pools in ocean of water</td>
<td>1. Pervasive gas saturated accumulations</td>
</tr>
<tr>
<td>2. Only high quality reservoir accumulates gas in place</td>
<td>2. Very large gas in place in reservoir of all qualities</td>
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<tr>
<td>3. Discovery is uncertain, recovery is certain</td>
<td>3. Discovery is certain, recovery is uncertain</td>
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<td>4. Discovery process is efficient</td>
<td>4. Recovery is inefficient but improves with technology</td>
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<td>5. R&amp;D to increase success</td>
<td>5. R&amp;D to improve recovery and characterization</td>
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<tr>
<td>6. Remaining resource, in small undiscovered pools, is small</td>
<td>6. Remaining resource in lower quality reservoirs is large</td>
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<td>7. Official view of WCSB remaining resources</td>
<td>7. US and industry view of WCSB remaining resources</td>
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<tr>
<td>“Glass is mostly empty”</td>
<td>“Glass is mostly full”</td>
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### Project Objectives

1. Communicate clearly the tight gas opportunity by establishing a **workable definition** for tight gas accepted by stakeholders

2. **Characterize** the tight gas opportunities into play types and analyze their supply trends

3. **Estimate** remaining tight gas resource potential and model its future conversion into supply.

4. Summarize resource and **supply potential** and **identify technology** and opportunities to maximize development of tight gas in Western Canada.
Gas Accumulation Types

Low permeability reservoirs contain GIP only in pervasive gas saturated regimes

Gas Resource Definition Issues

What are the dimensions?
What are the limits?
Tight Gas Resource Definition Criteria

- Pervasive gas saturation
- Free gas produced by gas expansion
- Clastic and carbonate reservoirs
- Reservoir quality continuum
- Technology application
- Economics

Reservoir Quality: The 0.1 mD Myth

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<th>Permeability, mD (average, in-situ)</th>
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<td>Tight Reservoirs</td>
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Tight Formation Designation

- US tax credit program for wells drilled 1977 to 1992
- Area-average in-situ formation permeability < 0.1 mD
- Historical tight gas designation generalized to basin-formation and field-formation – includes areas previously excluded
- New plays included based on USGS continuous accumulation criteria – not screened by permeability criteria
- In-situ permeability is difficult to measure and average
- Average permeability is only one of several factors that determine flow rate, ultimate recovery and economics

US tight gas plays include all reservoir qualities
Definition Workshop Outcomes

**Definition:** All gas resources occurring as free gas in the pores of clastic and carbonate reservoirs in regionally-pervasive continuous gas accumulations will be defined as tight gas resources. *Adopted working definition.*

Characterize the resource potential of the **complete spectrum of reservoir qualities** within these gas accumulations

Regionally-pervasive gas accumulations be classified as tight gas areas and reviewed in the following priority:

- **Deep Basin trap** *Primary characterization focus*
  - Shallow biogenic gas
  - Jean Marie Fm, B.C.
  - Additional accumulations
Plays and Characterization

Production by Tight Gas Region

Three major tight gas regions – all on growth trends

Jean Marie
Cum production: 1.3 tcf (raw)
4.5% of rate additions 03-05
2.5% of production 03-05

Deep Basin tight gas
Cum production: 17 tcf (raw)
21.5% of rate additions 03-05
15% of production 03-05

Milk River – Med Hat – 2WS
Cum production: 14 tcf (raw)
11% of rate additions 03-05
10% of production 03-05

Tight Gas Regions
Cumulative Raw Gas per Township, Bcf
Wells Onstream to 2005, Production to Feb 2007

Western Canada Tight Gas
Conclusions

• Unconventional gas is a significant and growing component of total gas supply, in both USA and Canada

• Tight gas is the largest part of the unconventional portfolio – over 30% of the WCSB output

• Supply potential and opportunities to increase tight gas supply not founded on consistent definition, play characterization and resource estimates

• Regionally pervasive gas accumulations host tight gas resources, regardless of the reservoir quality
  – The 0.1 mD cutoff is a myth

• Workable tight gas definition: free gas in the pores of clastic and carbonate reservoirs in regionally-pervasive continuous gas accumulations

Adopted definition is workable for developing resource estimates

Canadian Tight Gas:

*Developing and Applying a Workable Definition*

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November 15, 2007