BC Gas: Challenges and Opportunities

BC Natural Gas Symposium
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Forward Energy Group Inc.

- **Products and Services**
  - Gas Supply Update 2005
  - Tight gas resource characterization project with GSC
  - Play analysis and peer comparison, WCSB Foothills
  - Natural Gas Supply Trends in Western Canada 1990 – 2003
  - Play Entry Strategies in the Northern Foothills
  - Entry strategies into high impact plays, WCSB
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WCSB Production

- WCSB: recent peak at 16.9 Bcf/d in 2001, decreased to 16.5 in 2003 and rebounded to 16.7 Bcf/d in 2004
- BC production peaked at 2.7 Bcf/d in 2002, decreased slightly in 2003 and recovered to 2.7 Bcf/d in 2004

BC is the only province with a growing share of WCSB production
Supply Challenge: Sustain Production

- Total production flat at 16.7 Bcfd ± 0.2
- Decline in production from connected wells
- Rate additions from new wells onstream provide growth
- Wells onstream since 1989 produce 83% of gas

WCSB Gas Production by Period Onstream

- WCSB supplies 23% of consumption in US and Canada

How has industry responded?

- Connection activity reached record levels, above 17,000 connections, by the end of 2004
- Activity, and rate additions, responded to prices, cash flow, acquisition and capital markets, export capacity, etc.
How big is the annual challenge?

- Supply additions were 1.7 Bcfd in 1990, peaking at 3.9 Bcfd in 2001; 3.6 Bcfd average rate additions 2000-2004
- Shallow declines in early years; first year decline has increased from less than 30% to 40%
- Rate additions for all wells onstream in year is the peak monthly rate

WCSB Supply Additions

- WCSB: Very large area, many producing plays, very active
BC rate additions growing! 0.72 Bcfd in 2004

Hot spots sourced from a diversity of plays

Rate Additions per Zone Connected

- BC activity has increased, at a greater rate than WCSB
- Rate added by new BC events declined to 745 Mcfd per zone – more than triple the WCSB average of 217 Mcfd per zone
- Threshold size of an economic well decreased as gas price and netback increased

- Expanded opportunity set: smaller, higher cost, lower quality, higher risk or more remote prospects

More, but lower productivity, opportunities at the economic margin
Top BC Operators

- 80+ operators connected supply in BC in 2002-2004
- Top 3 operators dominating; they contributed over 47% of the rate additions
- EnCana, at an annual rate of 150 MMcfd, delivered 25% of 2002-04 rate adds

Few large players dominate; but many other operators

Rate Additions per Zone

- EnCana: many connections at average of 870 Mcfd
- Talisman: averaging over 8 MMcfd per zone; influence of Brazion b-60-E is very evident
- Most other top operators below the industry average of 870 Mcfd per zone connected

EnCana/Talisman: Contrasting styles both achieve growth
Rate Additions per Zone

- Foothills is most productive region at 3.6 MMcf/d per zone
- Average rates per zone for all other regions near average of 867 Mcfd per zone (02-04)
- Declines in initial rate per zone occurring in all regions: Deep Basin an exception

Rising gas price has enabled extension of economic rate limit
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Challenge for Gas Producers: Profitable Production Replacement

- Increasing decline, increasing costs, decreasing rate added per well
- Exploration and Development
  - Core areas maturing and declining
  - Opportunity set has expanded with increased netbacks and changed with advanced technology
- Property acquisition is expensive and a seller’s market
- Corporate acquisition, sale or merger

Status quo is not an option
Competing Forces

**Production Lost**
- Production Rate × Composite Decline Rate
  - Changing slowly
  - Low control

**Rate Additions**
- Wells × Rate Added per Well
  - Changing rapidly
  - High operator control

**Investment Environment**
- Portfolio
- Profitability
- Gas prices
- F&D costs
- Capital efficiency
- New opportunities
- Technology
- Cash flow
- Alternative investments

Activity

- Activity has increased about 5 times between 1995 and 2004
- Same trend in events connected and feet drilled in connected events
- Rate additions have not increased at same rate as activity

Increasing activity required for same result
Gas F&D Cost

• Gas-directed capital / extrapolated recovery in newly-connected zones

• Increasing at 15% per year since 1995

• Most of F&D cost increase is in lower EUR per well

• To sustain investment return, increasing F&D cost must be matched by increasing netback and therefore, increasing price

Increasing costs threaten profitability and investment

Rate Added per Well

• Production replacement efficiency has decreased by 12% per year

• In 2004, the same event connected and foot drilled resulted in only 30% of the 1995 rate additions per unit

• Supply from previously-unprofitable, lower deliverability opportunities has increased in response to higher prices and improved technology

Decreasing results for same activity is major driver of F&D cost increase
Cost inflation is minor driver of F&D cost increase

Drilling Cost per Foot

- Total drilling capital / Total feet drilled
- Cost per unit has been increasing at 5% per year since 1995
- Relatively slow increase in unit drilling costs applies to between 45% and 60% of gas intent capital

Drilling Cost per Foot

- Is cost inflation being offset by technology cost reduction?
- Is WCSB drilling cost trend biased by large volume of shallow gas drilling with better than average cost reduction?

- Compare BC data to WCSB data
  - Very little shallow gas in BC in time period
  - Lower activity in BC: 7% of WCSB footage, 13% of drilling expenditures
  - BC trend more volatile than WCSB
  - BC higher cost/foot than WCSB: almost 2X basin average
    - generally seasonal access
  - BC cost growth rate 1995-2004 only slightly higher than WCSB cost growth rate
  - BC cost growth rate 1999-2004 double WCSB cost growth rate
What will happen if gas prices flatten or decrease?

• Increased at 18% per year between 1995 and 2004
• Estimated 34% increase in price in 2005
• Commodity price increases support projects despite increased F&D cost

• Rate additions at increasing F&D costs sustained by increasing prices
• Activity and rate adds will decrease when price decreases

Industry is voting with its wallet

• Pre 2000, over 100% of cash flow reinvested in WCSB
• Post 2000, the re-investment ratio is less than 75%
Surplus cash flow was distributed either as income/dividends or invested outside the WCSB gas business: oilsands, frontier, international or downstream

• Alternative investment opportunities must be more attractive than WCSB gas projects
Profitable Production Replacement

- F&D costs have been increasing rapidly
- Cost inflation has not been the primary cause
- Decreasing rate additions and reserves per well has been the major driver of increased F&D costs
- Increased gas commodity prices have supported investment at the increased F&D costs
- Production replacement has not been limited by capital available for re-investment
- Operators must select investments where profitability is sustainable through volatile commodity price cycles

In a higher cost part of the basin, BC industry is extremely susceptible to flat/decreasing gas prices

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What is Tight Gas?

- In the US, “tight gas reservoirs generally are defined as gas-bearing rocks with an in-situ permeability to gas of less than 0.1 md” (Spencer, 1989)
- Most of these resources must be subjected to a significant degree of stimulation (e.g., hydraulic fracturing) or other “unconventional” production techniques to attain sufficiently economic levels of production.
- Since in-situ permeability data is not publicly reported for gas zones in the WCSB, we have estimated tight gas production on the basis of a number of criteria, including stratigraphic group, geographic region, the occurrence of fracture stimulation or horizontal drilling and depth.

Resource Triangle

- Produced Volumes
- Remaining Reserves
- Tight Gas
- Ultra Tight Gas Plays
- Shale Gas
- Gas Hydrates
- Deep CBM
- Undiscovered
- Conventional
- CBM
- Undiscovered
- Conventional
- Tight Gas

Resource Quality

Technology Requirement
Gas Production Profiles

US Lower 48
- Conventional gas in decline
- Tight gas in lower 48 at 20% of 2004 total
- CBM and shale gas significant

Western Canada
- CBM and shale gas insignificant
- Tight gas not reported
  - estimate over 25% of 2004 total
- Conventional gas in decline

Tight gas is future for both US and Canada

Tight Gas Not Reported in Canada

- Tight formation gas is not defined or distinguished from "conventional"
- Status of 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?
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Western Canada Tight Gas Resource Characterization Project

- Jointly funded by federal government (through Geological Survey of Canada) and petroleum industry operators
- Provincial stakeholders – regulatory agencies and ministries
- Multi-year scope – to conclude in March/07
- Big questions:
  - How much tight gas is there?
  - Where is it?

How important is tight gas to future Canadian supply?
**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 Resource Definition Issues**

- **Accumulation Type**
  - Small trap in large aquifer
  - Large trap ‘continuous’

- **Reservoir Quality**
  - Excellent
  - Very Poor

- **Gas Types**
  - Conventional Gas
  - Tight Formation Gas
  - Coalbed Methane
  - Shale Gas
  - Gas Hydrates
  - Other

**What are the dimensions?**
**What are the limits?**
Gas Accumulation Types

Recommendations

- **Definition:** All the gas resources occurring as free gas in the pores of clastic and carbonate reservoirs in regionally pervasive continuous gas accumulations should be defined as tight gas resources, for the purposes of this project.

- **Regionally-pervasive gas accumulations** be classified as tight gas areas and reviewed in the following priority:
  - Deep Basin trap
  - Jean Marie Fm, B.C.
  - Milk River and Medicine Hat pools

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

- Additional regionally-pervasive gas accumulations in Western Canada with significant resource potential should be identified.
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Tight Gas Play Examples

- For the purpose of this analysis, we illustrate three types of tight gas plays, as examples:
  - Shallow (SE Alberta/SW Sask.)
  - Jean Marie
  - Deep Basin
- The key uncertainty is the proportion of tight gas production from fracture-stimulated Mesozoic zones deeper than 6000 feet
- BC share: almost 0.7 Bcfd in 2004 (100% of Jean Marie and ~5% of Deep Basin)

Three tight gas plays – all on growth trends
Jean Marie

- Gas-charged, under-pressured shelf carbonates of the Devonian Jean Marie Formation in NE British Columbia, typically drained by horizontal wells

- Well depth: 4000-4500 ft – TVD:
- Horizontal leg length: average 2900 ft, up to 5000 ft

- Jean Marie sources produced about 0.5 Bcfd, 3% of 2004 WCSB production
Jean Marie Production

- 2004: 480 MMcfd from ~1000 wells onstream; average well rate: 480 Mcfd
- Very little base production; recent growth from application of technology

Jean Marie: Horizontal Drilling

- Full scale deployment of horizontal, under balanced drilling technology, commencing in 1999, enhanced play development
- Over 95% of recent wells in Jean Marie play are horizontal
- Productivity of horizontal wells 20-100% better than vertical wells
Jean Marie: Operators

- Jean Marie play characterized by few operators
- EnCana is the largest; nearly 450 MMcfd, or 60% of the total
- CNRL and Devon operated 24% and 7%, respectively

Deep Basin

- Definition of the Deep Basin characteristics:
  - Gas charged area in west-central Alberta (and parts of BC), just east of the Foothills disturbed belt
  - Located in recent to Jurassic stratigraphic groups
  - Deeper than 6000 ft

- A large portion of these reservoir rocks are low permeability, or ‘tight’

- Well depth: 7000-11,000 ft; average 8400 ft; predominantly vertical

- Stacked sands require commingling for optimal development

- The Deep Basin play produced about 2.6 Bcfd, 15% of 2004 WCSB production
Deep Basin

- Increasing activity: 2.9 Bcf/d from 7600+ wells onstream (to Apr05)
- Average well rate: 400 Mcf/d
- Steady production growth from 1990, 7%/year compound annualized growth rate
- BC portion: 160 MMcf/d ('04), 5.5% of total output

Deep Basin Production

Deep Basin tight gas: significant and growing
Deep Basin Fracture Stimulation

- A majority of the wells in this Deep Basin play are fracture stimulated.
- 80-85% of these rate adds from fractured wells.
- High cost to stimulate—especially in wells with multiple reservoir sands.

Fracturing technology - a necessary component

Deep Basin Operators

- Approximately 200 operators share the activity; no single operator dominates.
- Burlington largest operator; 1.0 Bcfd (23% of total play).
- BP and CNRL second largest, but only 9% of volume each.

Burlington: largest Deep Basin operator
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BC Gas – Key Messages

- WCSB on a treadmill, annual supply replacements nearly equal to annual withdrawals
- BC annual supply additions on an increasing trend – at nearly 0.8 Bcfd in 2004
- BC growing its share of total production
- Multiple successful gas supply growth strategies demonstrated by various operators
- To maintain profitability, cost growth must be managed
- In a higher cost part of the basin, BC industry is extremely susceptible to flat/decreasing gas prices

The sky is not falling - the sky is growing
The challenge is cost-effective rate additions
BC Gas – Key Messages

• Unconventional gas is one of the few components of the WCSB with sustainable growth potential

• CBM is in relative infancy in Canada; shale gas has yet to get started

• Tight gas is a continuing program, already significant in some plays

• Tight gas, developed through the resource play mechanism, is a major focus for selected operators

• Technology developments have been, and will continue to be a major factor in resource development

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