Identification of High Value Gas Plays in Western Canada

Bob Dixon and Dave Flint
Forward Energy Group Inc.

2007-05-28
Calgary, Alberta

Outline

• Introduction

• Production Replacement Challenge

• Gas Supply from the WCSB

• Supply Sources

• Unconventional Gas
Forward Energy Group Inc.

• Products and Services
  – Gas Supply Update 2006
  – Tight gas resource characterization project with GSC
  – Play analysis and peer comparison, WCSB Foothills
  – Natural Gas Supply Trends in Western Canada 1990 – 2005
  – Play Entry Strategies in the Northern Foothills
  – Entry strategies into high impact plays, WCSB
Identification of High Value Plays

- Define the appropriate metrics and measure the right things
- Segment the data to hi-lite and refine anomalies – start with the macro trends
- Mapping – visualize the trends and anomalies
- Know your competition – what to replicate, what to avoid
- Innovative techniques; Rigorous analysis

Where is the Growth?

- Within the overall steady-state performance of the WCSB, there are areas that out perform the average and areas that under perform
- Growth areas
  - Specific Geographic areas
  - Depth Classes
  - Deliverability Classes
  - Technology Applications (Well Orientation, Fracturing)
  - Internal Processes (Cycle Time)
  - Unconventional Gas
    - CBM
    - Tight Gas (Shallow, Deep Basin, Jean Marie)
Outline

• Introduction

• **Production Replacement Challenge**

• Gas Supply from the WCSB

• Supply Sources

• Unconventional Gas

---

**Challenge for Gas Producers:**

**Profitable Production Replacement**

- Increasing decline, increasing costs, decreasing rate added per well, etc.

Options:
1. Property acquisition
2. Corporate acquisition, sale or merger
3. Exploration and Development activities
   - New production from drilling, completing and connecting wells
   - Many strategy choices in Western Canada
   - Poor strategic decisions are expensive
   - Better strategic choices based on comprehensive, timely and consistent information

*Natural Gas Supply Trends provides better information*
Competing Forces

Investment Environment

Production Lost
Production Rate X Composite Decline Rate
• Changing slowly
• Low control

Rate Additions
Wells X Rate Added per Well
• Changing rapidly
• High operator control

Rate Losses and Rate Additions

• Rate loss from decline has increased from 2.5 Bcfd to 3.9 Bcfd in 2004
• Annual rate loss has averaged 3.7 Bcfd since 2001
• Net rate added has been decreasing
• 2002 correction may be a useful model for 2007

Rate losses and rate additions close to balance
Decline rate of all wells onstream is increasing at about 0.7% per year. The production gap grows larger each year because composite decline rate is increasing. Composite decline rate should stabilize around 25% after 2008.

Rate adds required to replace 25% decline on 16.8 Bcfd is 4.2 Bcfd—17% greater than recent average and 8% greater than 2001 record.

Total production grew by over 70% from 1990 to 2001. Total gas production recovering slowly since 2002. Wells onstream since 1989 produce 85% of gas. Likely decline in 2007 due to reduced gas drilling. 2006 production estimated at 17.0 Bcfd.
At 2004 production levels and decline rates, 3.2 Bcfd must be added simply to replace decline of production from wells onstream since 1990.

Additional decline in base volume of pre-1990 wells.

Solution gas is not a material source of supply.

Higher production rates require higher production replacement.

Aggregate production from all events connected by year onstream.

Peak = rate added.

Supply additions were 1.7 Bcfd in 1990, rising to 3.9 Bcfd in 2001.

Affected by prices, cash flow, acquisition and capital markets, export capacity, etc.
Rate Added per unit of activity

- Production replacement per foot drilled has decreased by 12% per year
- In 2005, 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 the consistent driver of F&D cost increase

Drilling Cost per Foot

- Total drilling capital / Total feet drilled
- Cost per unit has been increasing at 9% per year since 1999
- Rapid cost increases in 2005 (14%) and continuing at least 15% into 2006

Cost inflation is accelerating, driving F&D costs
**Gas F&D cost**

- Gas-directed capital / extrapolated recovery in newly-connected zones
- Increasing at 21% per year since 1999
- 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.

**Gas Price**

- Increased at > 22% per year between 1999 and 2005
- Commodity price increases supported projects despite increased F&D cost
- Estimated 20% decrease in price in 2006

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

---

*Source: Forward Energy, CAPP, ARC Financial*
Drilling Response

- Active gas rigs dropped below 2005 levels in August 2006
- Dropped below 2004 levels in October
- Year to date 2007 active gas rigs are 60% of the comparable 2006 period, 70% of last 3 years

- Operators have announced reduced shallow gas and CBM programs
- Lower utilization rate of shallow rigs

Rapid response after a record first quarter of 2006

Profitable Production Replacement

- F&D costs have been increasing rapidly
- Decreasing rate additions and reserves per well has been the major driver of increased F&D costs
- Cost inflation has been a recent contributor
- Increased gas commodity prices supported investment at the increased F&D costs until 2006
- Current slowdown in drilling will result in lower supply, higher gas prices and, in time, lower input costs
- Operators must select investments where profitability is sustainable through volatile commodity price cycles and inflationary cost pressures
Outline

- Introduction
- Production Replacement Challenge
- Gas Supply from the WCSB
- Supply Sources
- Unconventional Gas

Gas Connection Activity

- Activity has increased about 5 times between 1995 and 2005
- Same trend in events connected and feet drilled in connected events
- Rate additions have not increased at the same rate as activity
- Events connected 2006 about same as 2005

Increasing activity required for same result
Natural Gas Supply Trends

Event Count per Township
Events Onstream 2003 - 2005

High connection density in resource plays

Connected Area
Connected area of basin doubled since 1989; Over 4700 townships connected by 2002
Fewer townships connected in latest 3 years; Both new areas and infills – remaining opportunity

2005 Rate adds lower than 2001
Natural Gas Supply Trends

Rate Added per Township
Events Onstream 2003 - 2005, MMcfd

21 townships where over 30 MMcfd connected

Basinwide trends and anomalies
With 1920 MMcf/d, EnCana ranked 1st in terms of cumulative rate additions for 2003-2005; Talisman, with 493 MMcf/d, ranked 5th. Industry total = 11.1 Bcf/d for 2003-05; average of 3.7 Bcf/d per year. Top 10 operators controlled 58% of total rate adds, or 6.4 Bcf/d. 19 Trusts in top 50, added 1.4 Bcf/d, 13% of total.

EnCana and Talisman combined: 22% of industry rate adds

EnCana and Talisman selected to show range in geographic diversification and differences in focus; both companies are high profile in WCSB gas. EnCana: resource play focus. Talisman: focus in deeper, higher rate plays.

EnCana and Talisman selected to show range in geographic diversification and differences in focus; both companies are high profile in WCSB gas. EnCana: resource play focus. Talisman: focus in deeper, higher rate plays.
Discounted Production

Which Production Profile is More Valuable?

- Evaluation criteria
- Reserves or flowing BOE basis?
- Equal value on a reserves basis
- High rate well over 4 times as valuable on a flowing BOE basis in first year
- Is there a better measure of value?

Discounted Production Compares Time Value of Production

- Discounted production applies a time-value factor to the production stream
- 10% discount applied to decline function
- High rate well only 1.4 times as valuable as the low rate well on a discounted production basis

Reduces comparison to single consistent value
Outline

• Introduction

• Production Replacement Challenge

• Gas Supply from the WCSB

• Supply Sources

• Unconventional Gas
Supply Sources

- Exploration and Development Strategy
- Discovery Period
- Geographic Region
- Stratigraphic Group
- Depth Class
- Deliverability Class
- Completion Type
- Cycle Time
- Well Orientation
- Fracture Stimulation
- Coalbed Methane

Activity by Deliverability Class

- Extraordinary growth in the number of low rate (<0.5 MMcf/d) connections since 1995
- The number of connections in the higher rate classes has remained relatively constant until 2002
- Connection activity of low deliverability zones decreases when gas price decreases

Growth in activity is all in low deliverability wells
**Rate Additions by Deliverability Class**

- Ninefold increase in rate adds from the lowest deliverability class
- Rate additions from low deliverability events (<2.0 MMcfd) increased from 37% to almost 80% of annual rate additions in 2005
- High deliverability zones (>4 MMcfd) maintained relatively constant additions until 2002

**Growth in overall rate additions has come increasingly from low deliverability wells**

**Low Deliverability:**
37% of rate additions
42,370 zones connected

**Deliverability Class: 0 to .5 MMcfd**

Rate Added per Township
Events Onstream 2003 - 2005, MMcfd

Natural Gas Supply Trends

Low deliverability zones connected everywhere
Highest density in SE Alberta – SW Sask
High Deliverability:
15% of rate additions
242 zones connected

% of Rate Additions by Deliverability Class
Original Operator Rank 1 to 25, Events Onstream 2003-2005

Talisman: 40% of rate adds from connections with deliverability greater than 4.0 MMcfd

EnCana: 65% of rate adds from connections with deliverability less than 1.0 MMcfd

EnCana and Talisman: significantly different styles
- Although the number of events connected at depths less than 4000’ increased almost fivefold between 1995 and 2005, rate added increased by less than 20%.
- Rate adds from zones below 8000’ have been increasing steadily.
- Rate adds from the 2000-4000’ depth class also increasing.

Activity shifted to low deliverability shallow gas

- Annual additions from vertical wells fell from 90% of the total in 1990 to average 65% since 2001.
- Rate adds from deviated wells have averaged about 25% of the total since 2001.
- Horizontal wells have provided about 10% of rate adds since 1997.

Additions from deviated and horizontal wells increased to 35% over the study period.
Rate Additions from Horizontal Wells
Original Operator Rank 1 to 25, Events Onstream 2003-2005

- **EnCana**: 480+ MMcfd (25%); Avg. = 0.8 MMcfd per connection
- **Talisman**: 170 MMcfd (34%); Avg. = 4.6 MMcfd per connection

**Total**: EnCana and Talisman combined: 52% of horizontal rate adds
Fracture-stimulated zones are a rapidly growing component of supply.

Fracture-stimulated zones accounted for 57% of the rate added during the focus period.

More than three out of every four zones connected between 2003 and 2005 was fracture-stimulated.

Upper Cretaceous zones highest absolute and % rate adds from fracture-stimulated zones.

Upper Mannville was the 2nd largest source of fracture-stimulated rate adds.

Over 2/3 of rate adds in Lower Mannville and Triassic were from fracture-stimulated zones.
In Lower Mannville reservoirs, rate added from fracture stimulated zones accounted for 69% of the total.

Concentrations of rate additions:
- Cadomin in Cutbank BC, Wapiti Leland, Wild R.
- Ellerslie in WC Alberta
- Basal Quartz in the High River field

Fracture stimulation focused on Deep Basin plays.

Median cycle time decreased from over 16 months in 1990 to about 3 months in 2001.

Jumpshift from connecting drilled wells in inventory to just-in-time drilling.

No improvement in median since since 2001.
Cycle Time Class

- Just-in-time connections, less than 180 days, contributed the majority of the rate additions
- Supply from the inventory of older wellbores, whether unconnected wells or recompletions in connected wells, has been declining as a proportion of the mix

- Supply added from wells drilled over 15 years prior to connection has decreased to less than 5% since 2001

Just-in-time completions over 70% of rate adds

Median Cycle Time by Original Operator
Wells connected 2003-2005, 50 largest operators by rate adds

WCSB (single completions)
Top 50 Operators
Median: 89 days
Connection Count: 32065
(all Top 50 operators displayed)

Wide range of cycle time performance – not just across all operators, but within operators
Outline

• Introduction

• Production Replacement Challenge

• Gas Supply from the WCSB

• Supply Sources

• Unconventional Gas

What's in a name?

<table>
<thead>
<tr>
<th>CONVENTIONAL</th>
<th>UNCONVENTIONAL</th>
</tr>
</thead>
<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>
</tr>
<tr>
<td>3. Discovery is uncertain, recovery is certain</td>
<td>3. Discovery is certain, recovery is uncertain</td>
</tr>
<tr>
<td>4. Discovery process is efficient</td>
<td>4. Recovery is inefficient but improves with technology</td>
</tr>
<tr>
<td>5. R&amp;D to increase success</td>
<td>5. R&amp;D to improve recovery and characterization</td>
</tr>
<tr>
<td>6. Remaining resource, in small undiscovered pools, is small</td>
<td>6. Remaining resource in lower quality reservoirs is large</td>
</tr>
<tr>
<td>7. Official view of WCSB remaining resources</td>
<td>7. US and industry view of WCSB remaining resources</td>
</tr>
</tbody>
</table>

“Glass is mostly empty”

“Glass is mostly full”

Models define how we evaluate potential
Unconventional gas is largest source in the US

Natural Gas Production by Source, 1990-2030

Largest single source of supply since 2000
Tight formation gas is largest unconventional type

Unconventional Natural Gas Production by Type 1990-2030

- Tight sands
- Coalbed methane
- Gas shales

EIA AEO 2007

Largest single source of supply since 2005

Gas Production Profiles

- US Lower 48 Gas Production, by Resource Type
- Western Canada

- Conventional gas in decline
- Tight gas in lower 48 over 30% of 2005 total
- CBM and shale gas significant

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

CBM: 240 MMcfd in '05
Shale: none

Better understanding of tight gas is important
Reservoir quality: The 0.1 mD Myth

<table>
<thead>
<tr>
<th>Class</th>
<th>Tight Reservoirs</th>
<th>Conventional Reservoirs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Quality</td>
<td>None</td>
<td>Poor</td>
</tr>
<tr>
<td>Permeability, mD (average, in-situ)</td>
<td>0.0001</td>
<td>0.001</td>
</tr>
</tbody>
</table>

**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**
Reservoir quality: The 0.1 mD Myth

Rate - Depth Limits for Tight Formation Gas

- Rate-depth limits classified formations with low productivity for their depth as tight formation gas
- Shallow biogenic gas

US tight gas plays include all reservoir qualities

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?
Definition

**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.*

The resource potential covers a wide spectrum of reservoir qualities within these gas accumulations.

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

- Deep Basin trap
  - 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
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

Deep Basin Growth Plays

- Cadomin, Gething, Spirit River, Cardium
- Multiplay to grow even more with commingling (Development Entity)

Deep Basin plays growing source since 2002
Conclusions

- The output from the WCSB has plateaued at 16-17 Bcfd
- There are growth stories within the large and dynamic mix of plays / areas / technologies etc.
- Having the right tools and defining and exploiting the appropriate metrics leads to an improved understanding - better decisions will result
- Unconventional gas production is growing while production from conventional sources decline
- Regionally pervasive gas accumulations host tight gas resources, regardless of the reservoir quality
  - The 0.1 mD cutoff is a myth
- Production from tight gas areas comprises over 30% of current WCSB production and the Deep Basin trap remains the largest current source of tight gas in the WCSB

Impact on supply will be evolution, not revolution

Identification of High Value Gas Plays in Western Canada

Bob Dixon and Dave Flint
Forward Energy Group Inc.

www.forwardenergy.ca
bob.dixon@forwardenergy.ca
403.261.1019

2007-05-28
Calgary, Alberta