North American Unconventional Oil and Gas: And Now for the Hard Part?

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PFC Energy North American Onshore Service
What Is Happening
Thinking About Unconventional Resources

- Cows: 520 MMtons
- Sheep and Goats: 105 MMtons
- Chickens: 48 MMtons
Question 1: What About Ants? (Yes, Ants)

- What is the total estimated biomass of all the ants in the world, in kilotons?

  a) 25
  b) 75
  c) 600
  d) 5,000
Thinking About Unconventional Resources

Hydrocarbons are naturally distributed such that difficult and expensive resources are much larger than easy and cheap oil and gas.

Graphic courtesy of Steve Sonnenberg, Colorado School of Mines

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Technology Has Evolved to Overcome Energy Inefficiency

The Problem with Ants (and Unconventional Resources):

If you pick them up and eat them one at a time, energy output is greater than input.

The Solution
We Are Getting After It…

- Unconventionals (shale, tight, and CBM) have come to dominate new source production

**Contribution to Total Peak Output from New Wells**

![Graph showing contribution of unconventional and conventional sources from new wells over time.](image)

Source: PFC Energy, DrillingInfo, RigData, state databases
But the Transition to Liquids is Slow

- Wells with >50% Liquids account for half of all wells drilled
- But most of the gain has come from Dry Gas activity falling

**Lower 48: New Wells by Fluid Type**

- Oil (90%+Liq)
- Dry Gas (90%+ Gas)
- Gassy Oil (50%-90% Liq)
- Wet Gas (50%-90% Gas)
- Gassy Oil and Oil as %

Source: PFC Energy, DrillingInfo, RigData, state databases
Note: Excludes non-Marcellus wells in Appalachia reported only annually
Question 2: So Is It Working?

Which countries has the combination of Bakken + Eagleford surpassed in terms of total wellhead liquids production?

a) Ecuador (OPEC member)

b) UK

c) Indonesia

d) All of the above

e) None of the above
Oil Growth Is World Scale

- Hyperactivity growing play-level production rapidly
- Expansion of wellhead production out of synch with mid-stream and downstream, leading to basis blowouts and local surpluses

**Bakken + Eagleford Wellhead Liquids Production**

Shale oil production is still small from a global view but forms a major part of global new source supply.

Data: PFC Energy, HPDI, State Data
Since 2008, gas supply has climbed considerably, even in the face of enormous a declining rig count and price level. This has led to a view of permanent bearishness.
Gas production in the US has been incredibly resilient even though prices and rig activity have continued to fall dramatically. This is due to many reasons, but the single most important one in 2011 was:

a) Impressive high-grading of drilling locations by industry

b) The wave of associated gas being produced in the stampede to liquids.

c) Well productivity gains due to better well technology and completion techniques
We’re Skewed!

- Plays are not created equally. Thus, the NA supply system is composed of a relatively small number of highly productive wells and long tail of very small contributors
  - Stop looking at the gas rig count simplistically
  - What matters is the trend within the categories

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Data Source: PFC Energy; State oil and gas databases; Drillinginfo
Excludes GOM Deepwater, CBM & non-Marcellus Appalachian wells from states with annual/quarterly reporting
Why the Future May Be Different
Focus on What Matters

- While focus is on emerging plays, well-established plays are the backbone of new source gas production
- Relatively few plays are operators can move the needle for the US

2011 Gas Wedge By Play

2011 Gas Wedge by Operator

Source: PFC Energy-Guggenheim, DrillingInfo, RigData, state databases
What Will Happen As the Plays Evolve?

- It is a mistake to treat plays as static; they pass through distinct life stages
- Each stage requires a different set of skills and resources to succeed

Life Stages of Unconventional Plays

- Prove It (Infancy)
- Optimize It (Adolescence)
- Standardize It (Adulthood)
- Re-invent It (2nd Career)
What Matters for the Future of a Particular Play?

- Each play is unique and unfolds in three dimensions:
  1. Spatially – How does the play develop geographically and where are the sweet spots?
  2. Distributionally – How good is good?
  3. Temporally – How does the play change over time?

- Let’s take a “live” look at three plays to show each of these aspects of the play.
Well productivity is not randomly distributed, but rather clusters in sweet spots.
Question 4: How Far Ahead?

- Looking at relative peak per lateral foot productivity of all wells in the Bakken, the most productive quintile is how much better than the bottom quintile?

  a) 10% better

  b) 100% better (twice as productive)

  c) 1,000% (10x as productive)

  d) 10,000% (100x as productive)
The inherent variability of rock productivity is far larger than differences in cost structures or operational practices.
Question 5: How Fast Are We Learning?

- In 2008, EOG's wells in the Bakken exhibited peak month production of about 185 boed/per 1000 lat ft. What was that number in 2011?
  a) That was the Stone Age! We've made leaps and bounds since then. 375
  b) Steady improvements have pushed it up. 240
  c) The more things change, the more they stay the same. 185
  d) Going down the drain... 50
Engines of Growth in Major Gas Plays Have Hit Limits

- The top 5 gas plays all appear to have hit limits to have optimized lateral length and peak the gas extracted per lateral ft of reservoir.
- Without these “engines,” growing supply becomes more difficult.

![Graph showing average peak month production, average lateral length in ft, and average peak month production per lateral ft for different gas plays.](image-url)
Companies rightly seek to exploit the sweet spots first, but this leads over time to quality degradation in the play unless technology leaps forward.
No one should be drilling in the Haynesville today. The play is uneconomic.

a) True. Those guys are setting money on fire.

b) False. This is the most productive play in the country.

c) Kinda…sorta…it depends.
Play Works…for Some

- Haynesville Signal-to-Drill is a better indicator than spot prices of the returns seen by an E&P company.
- 1st Quintile wells modestly profitable, but most locations play are far from being economic. Prices would need to rise to induce significant new drilling.

**Haynesville Signal-to-Drill and PV10 Quintile Breakeven Prices**

Source: NYMEX, PFC Energy, DrillingInfo, State databases
Key Takeaways

1. Unconventional oil and gas are down the resource pyramid -- much larger than conventional resources, but difficult and expensive.
2. Oil and gas are booming, and the results are world-scale.
3. The North American supply system exhibits enormous skew both between and within plays.
4. Plays pass through a number of life stages, and the main contributors to new source volumes are mature.
5. Within an unconventional play, there is enormous, inherent variability, separating winners from losers: the chess board is set.
6. Future production gains will have to struggle against:
   - The petering out of growth accelerants which characterized early stages.
   - Sweet spot exhaustion/quality degradation, which may well outpace technology gains.
7. We will be drilling these plays for decades, but activity levels and breakeven prices will need to rise from here.
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