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

September 2012

PFC Energy North American Onshore Service

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What Is Happening

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Thinking About Unconventional Resources

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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

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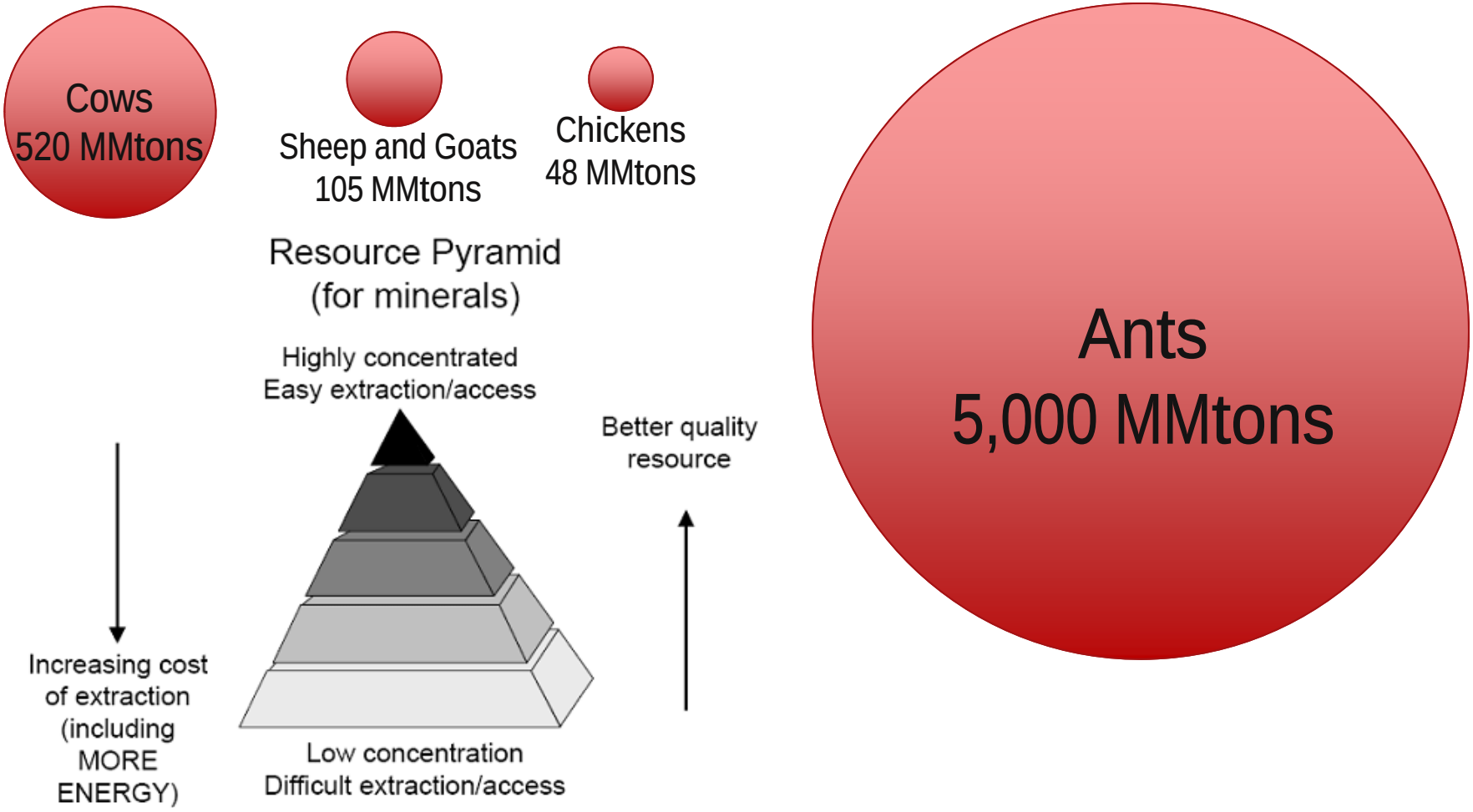
Thinking About Unconventional Resources



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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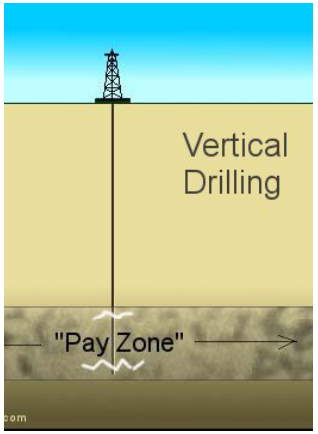
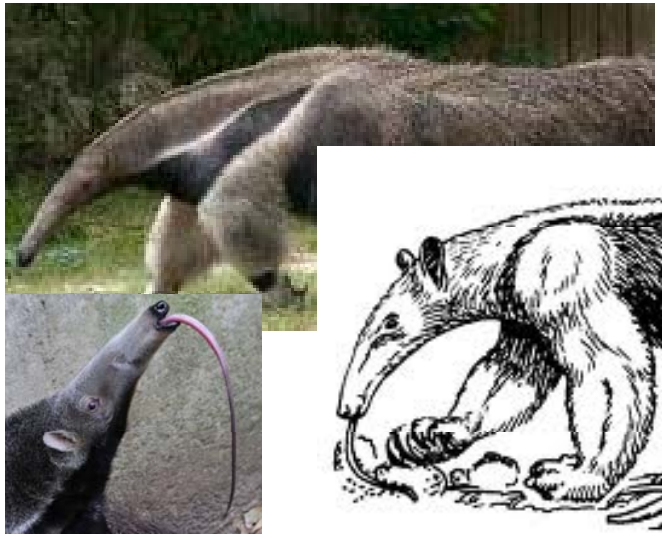
Technology Has Evolved to Overcome Energy Inefficiency

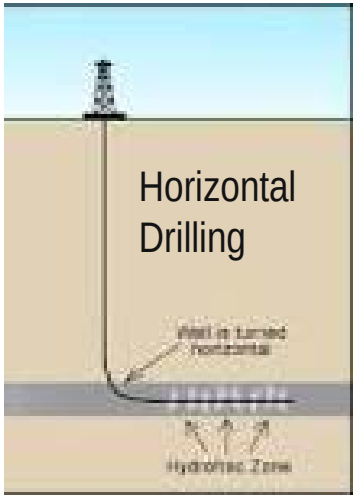
The Problem with Ants (and Unconventional Resources):

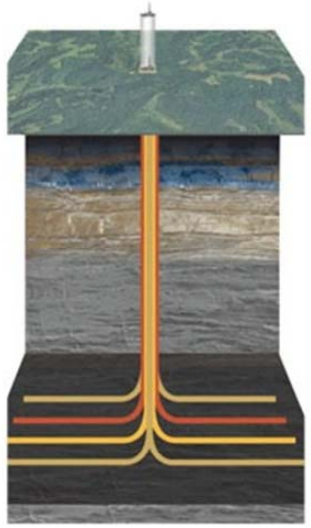
If you pick them up and eat them one at a time, energy output is greater than input.



The Solution







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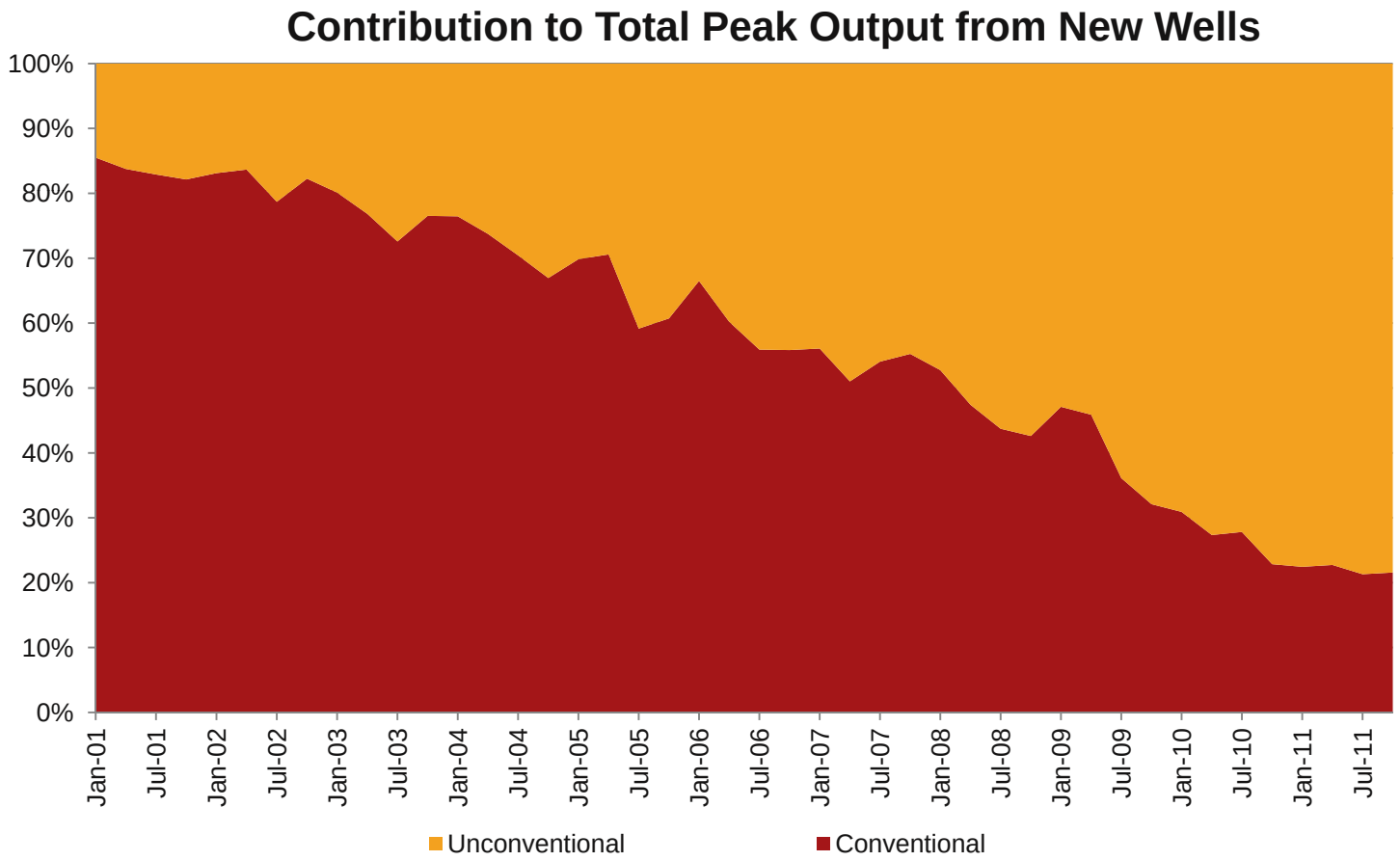
We Are Getting After It…

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



Source: PFC Energy, DrillingInfo, RigData, state databases

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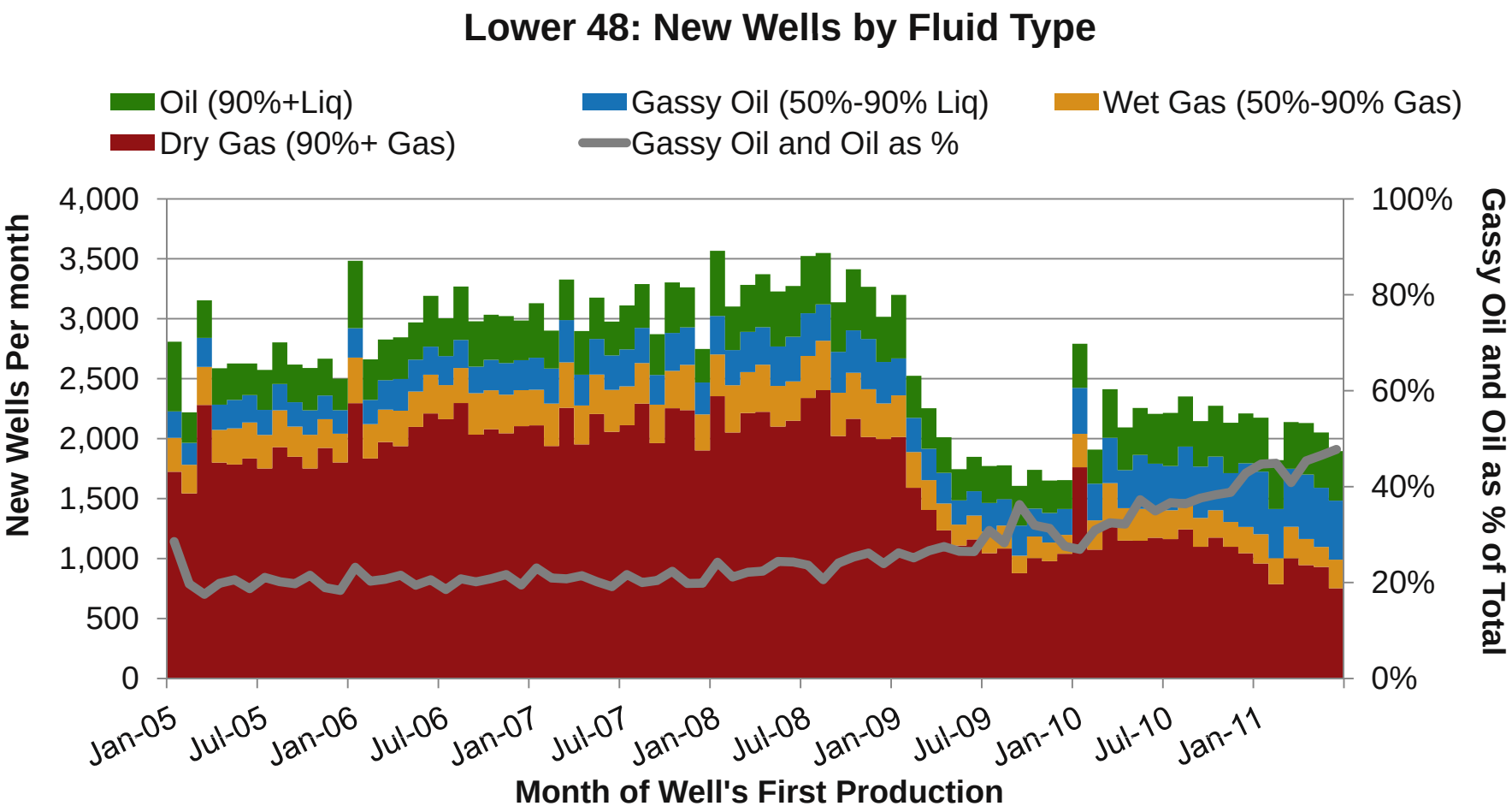
But the Transition to Liquids is Slow

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



Source: PFC Energy, DrillingInfo, RigData, state databases
Note: Excludes non-Marcellus wells in Appalachia reported only annually

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Question 2: So Is It Working?

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

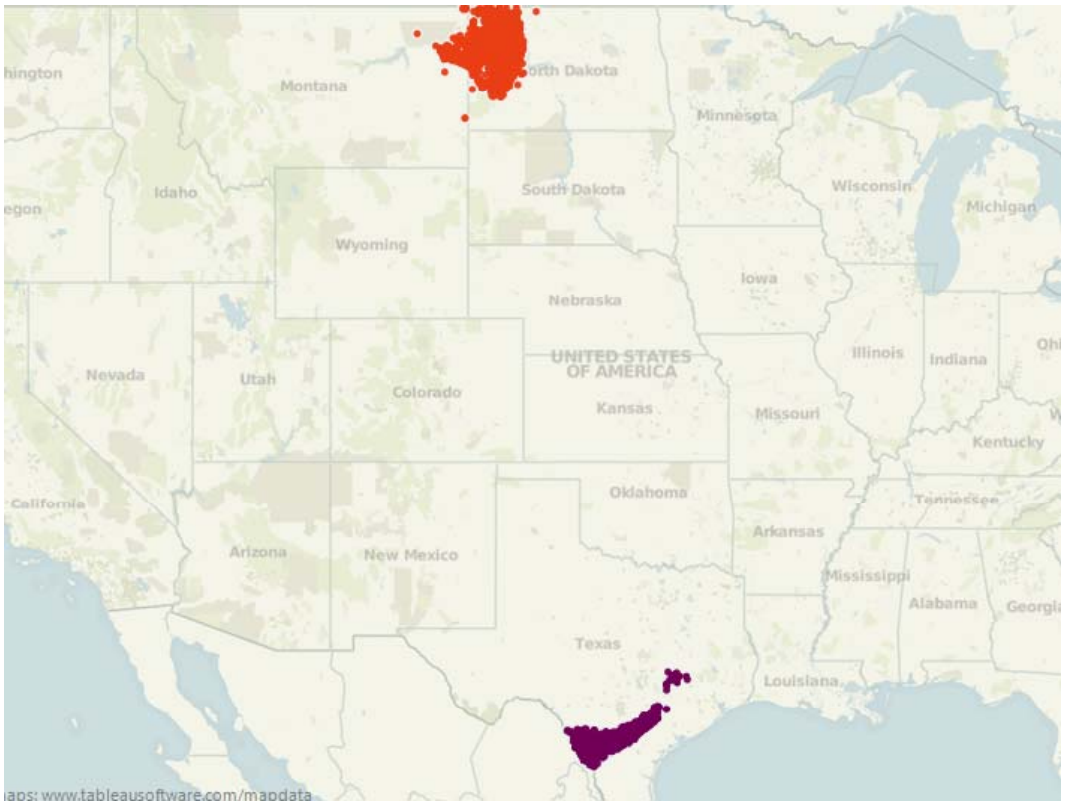
a) Ecuador (OPEC member)

b) UK

c) Indonesia

d) All of the above

e) None of the above



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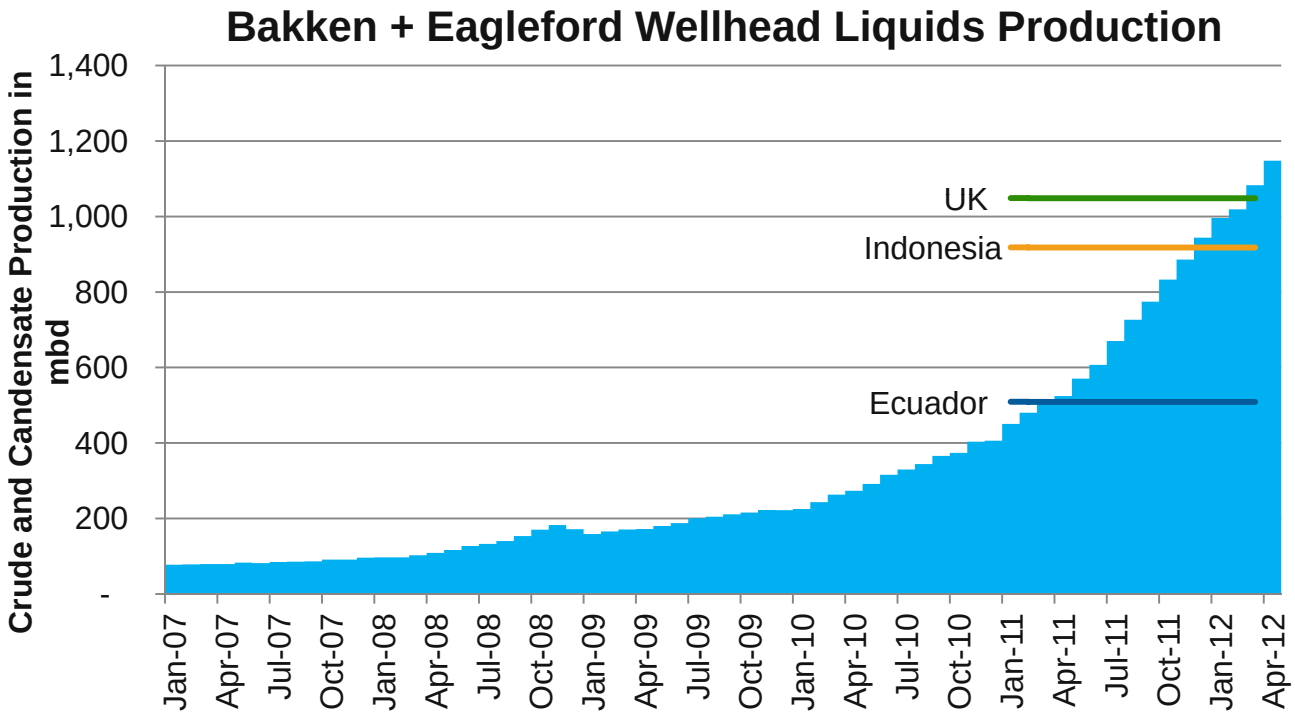
Oil Growth Is World Scale

- 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



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

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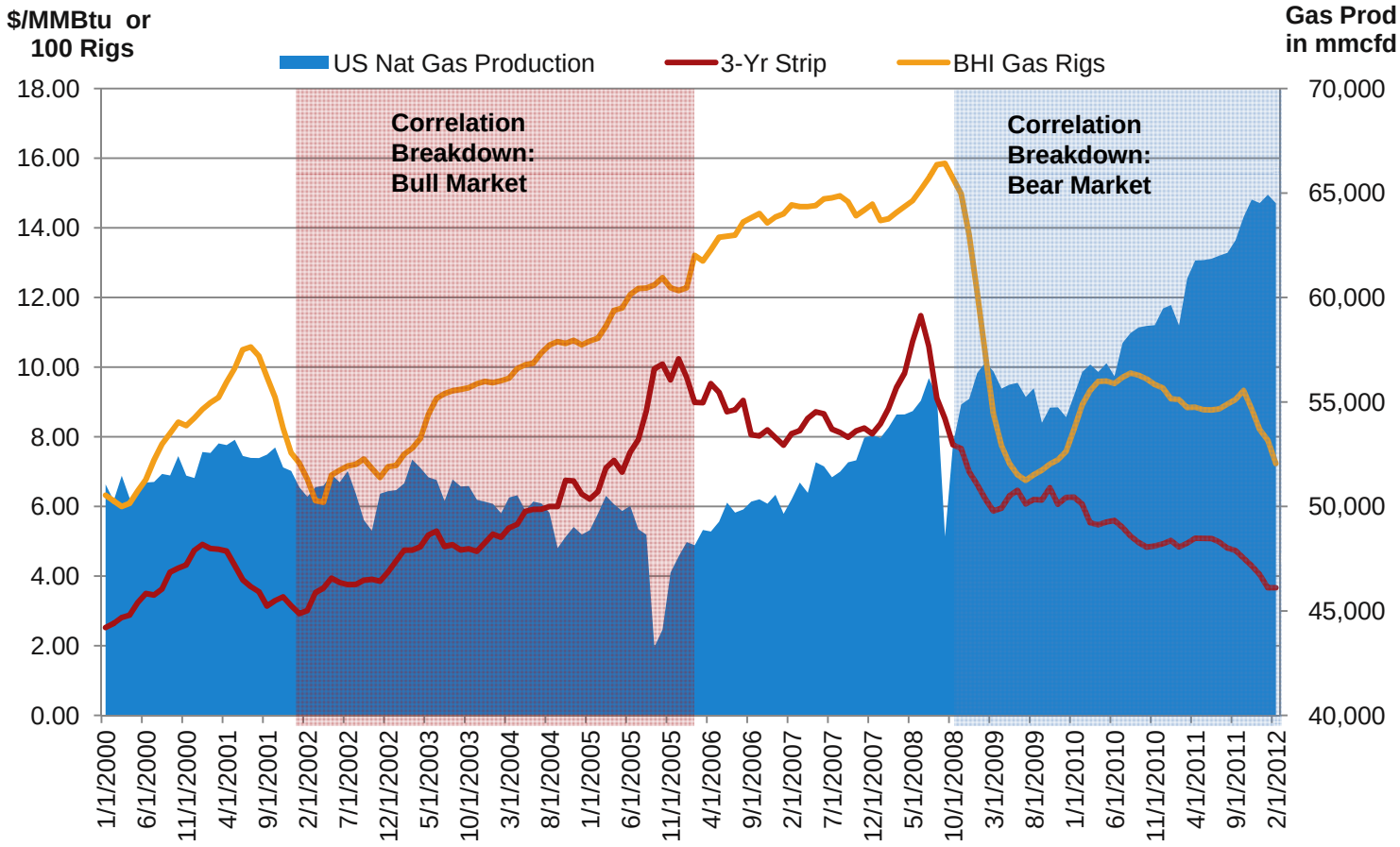
The Gas Conundrum

- 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.



Source: PFC Energy, DrillingInfo, RigData, state databases

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Question 3: The Source of the Gas "Problem"

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:

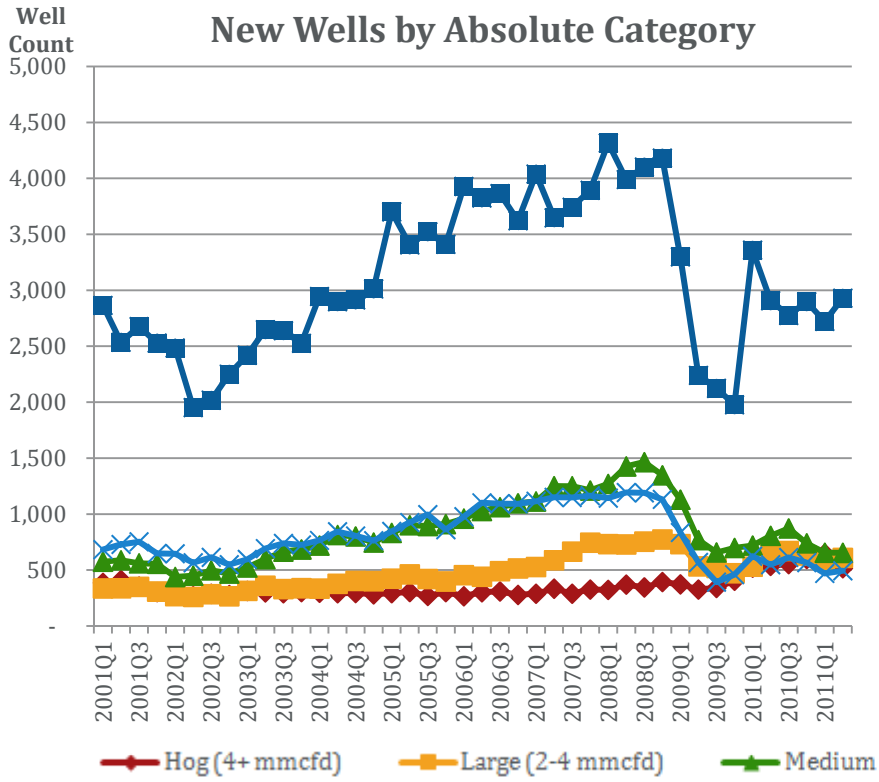
a) Impressive high-grading of drilling locations by industry

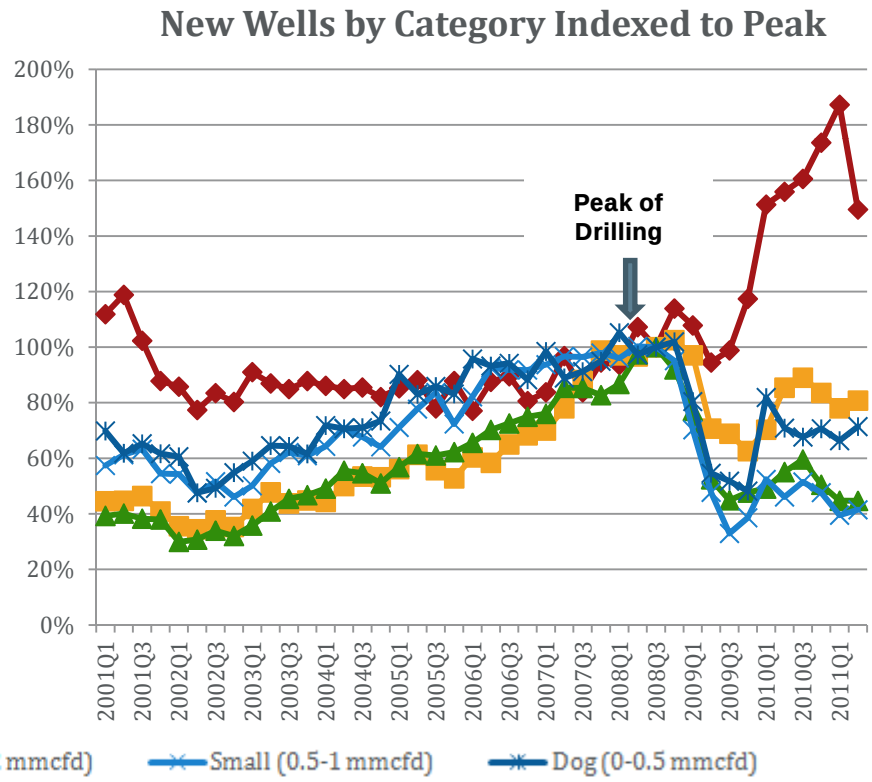
b) The wave of associated gas being produced in the stampede to liquids.

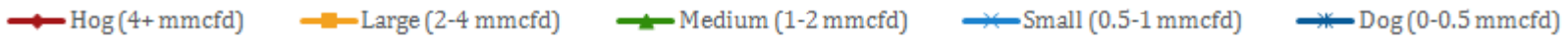
c) Well productivity gains due to better well technology and completion techniques

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







Data Source: PFC Energy; State oil and gas databases; Drillinginfo
Excludes GOM Deepwater, CBM & non-Marcellus Appalachian wells from states with annual/quarterly reporting

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Why the Future May Be Different

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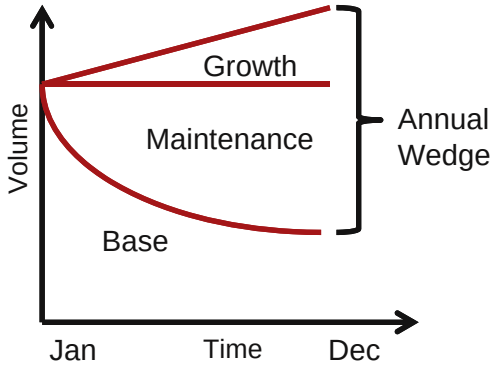
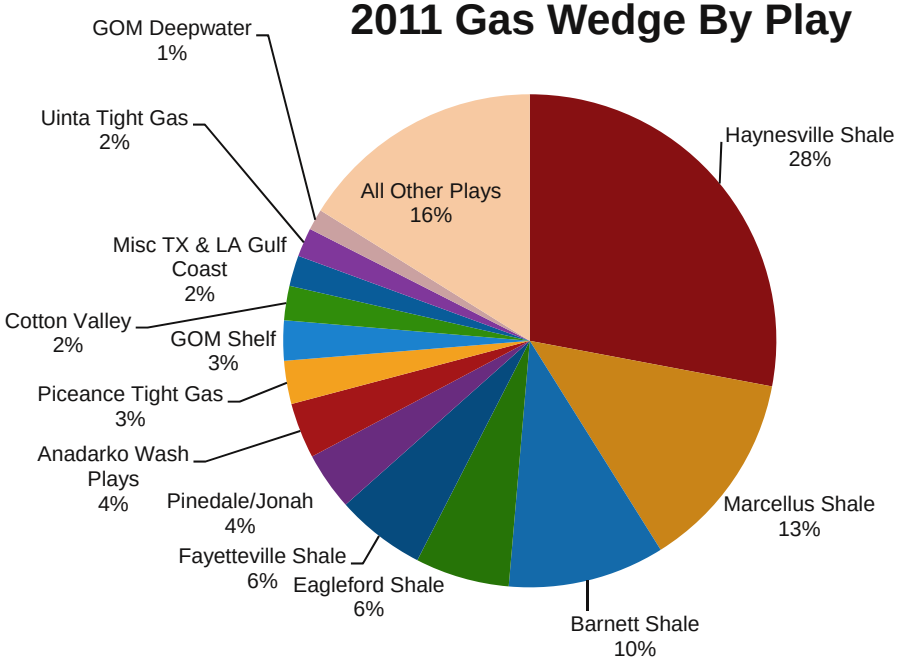
Focus on What Matters

- 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

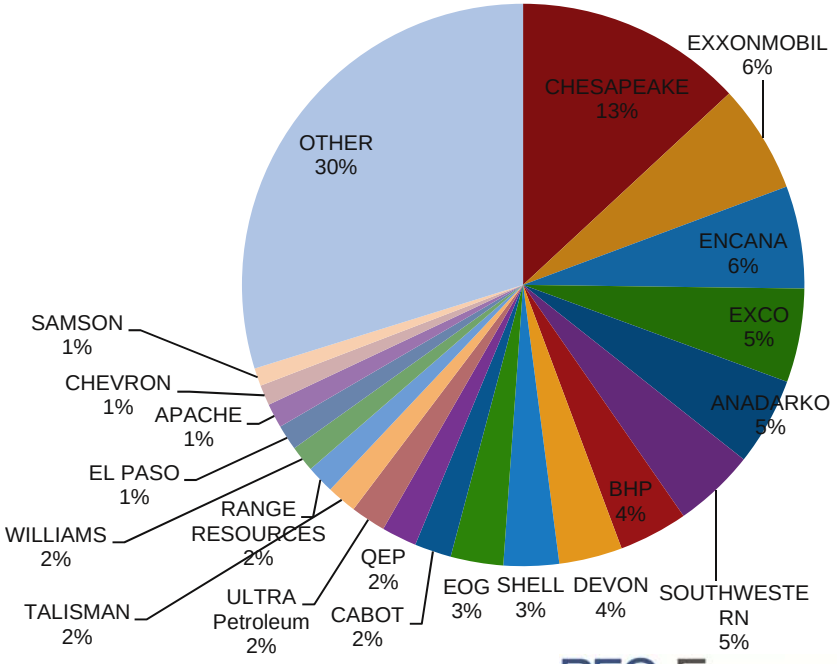
Annual "Base" and "Wedge" Combine to Form Production



2011 Gas Wedge By Play



2011 Gas Wedge by Operator



Source: PFC Energy-Guggenheim, DrillingInfo, RigData, state databases

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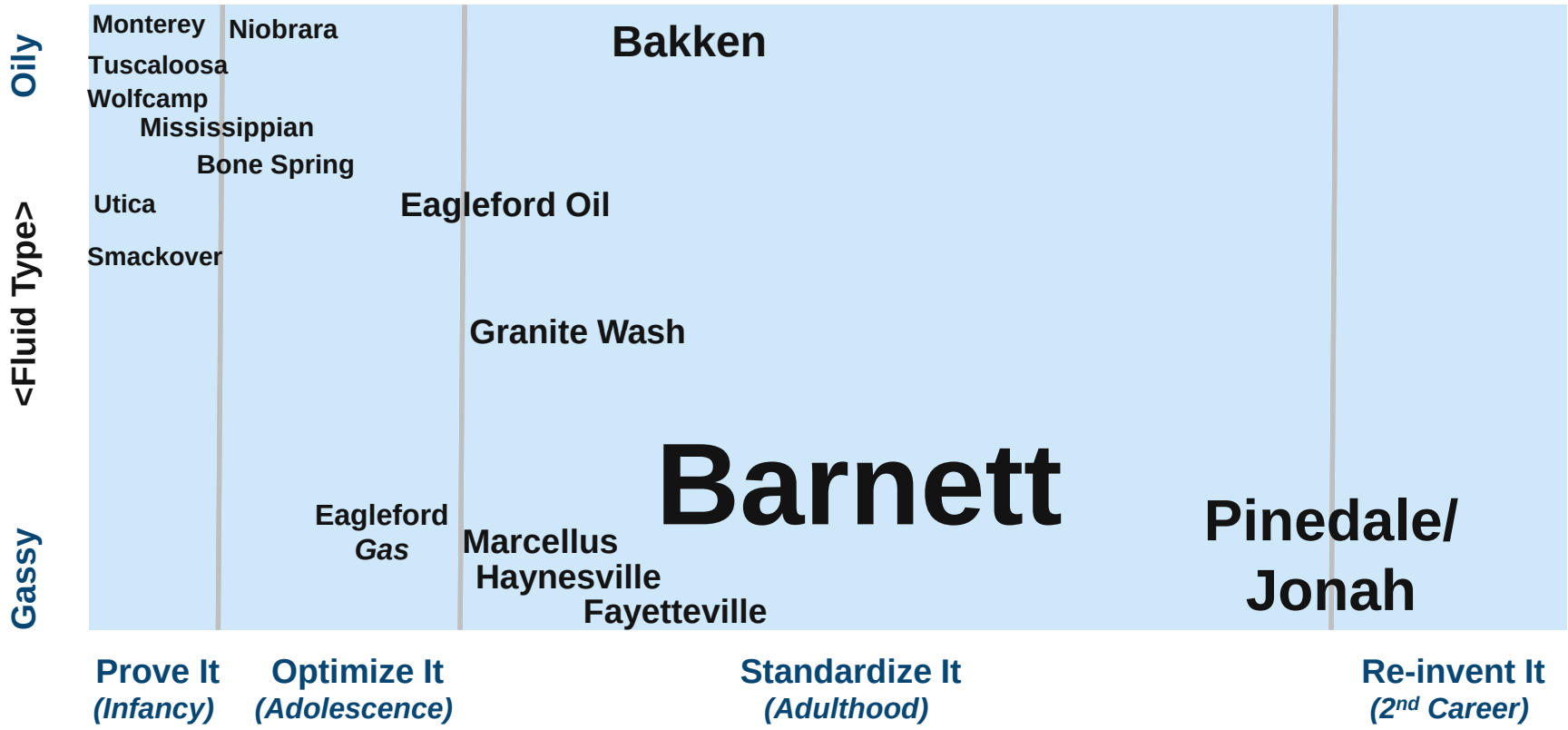
What Will Happen As the Plays Evolve?

- 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

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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.

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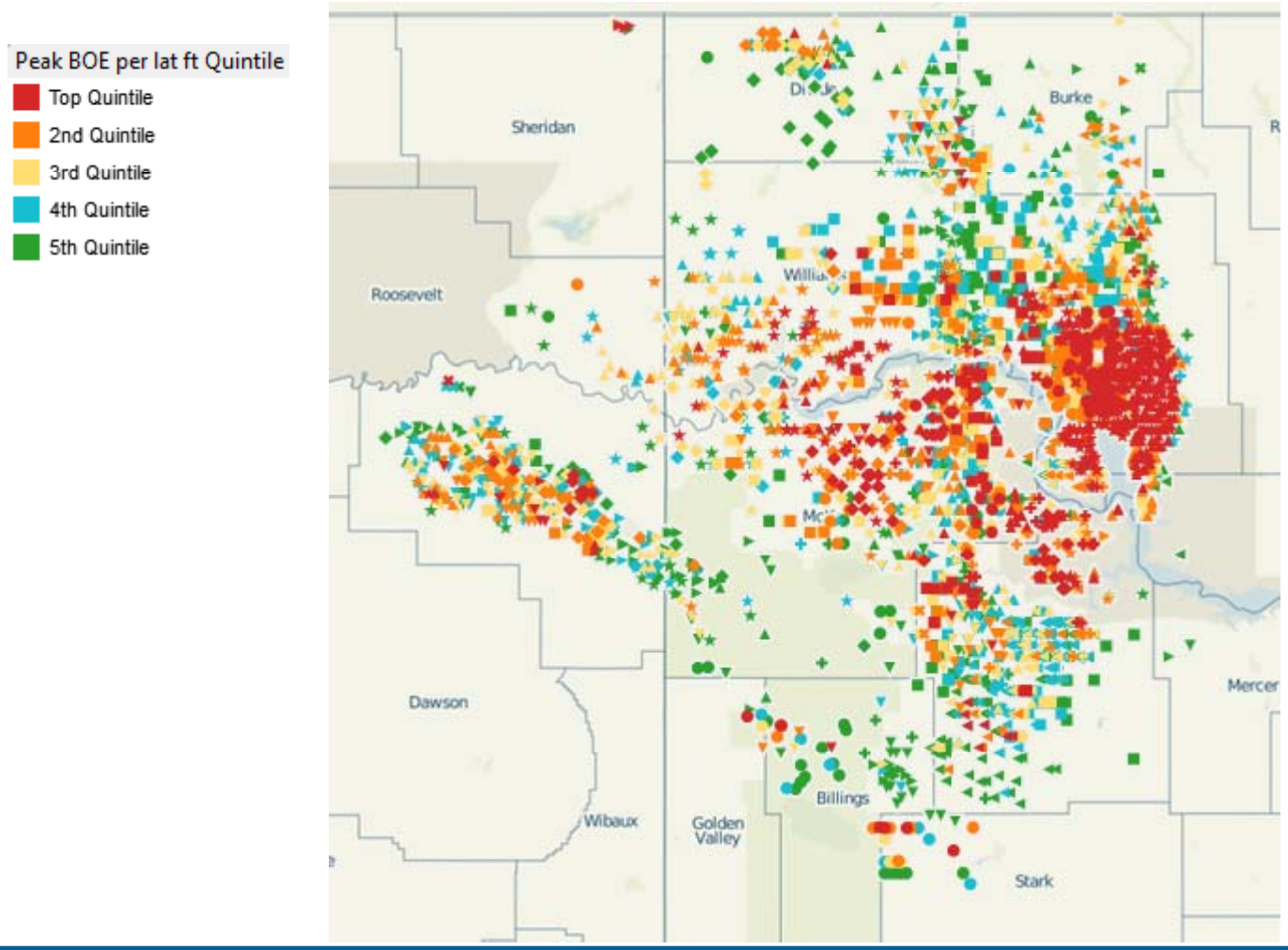
Quality Map of the Bakken



Well productivity is not randomly distributed, but rather clusters in sweet spots.

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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)

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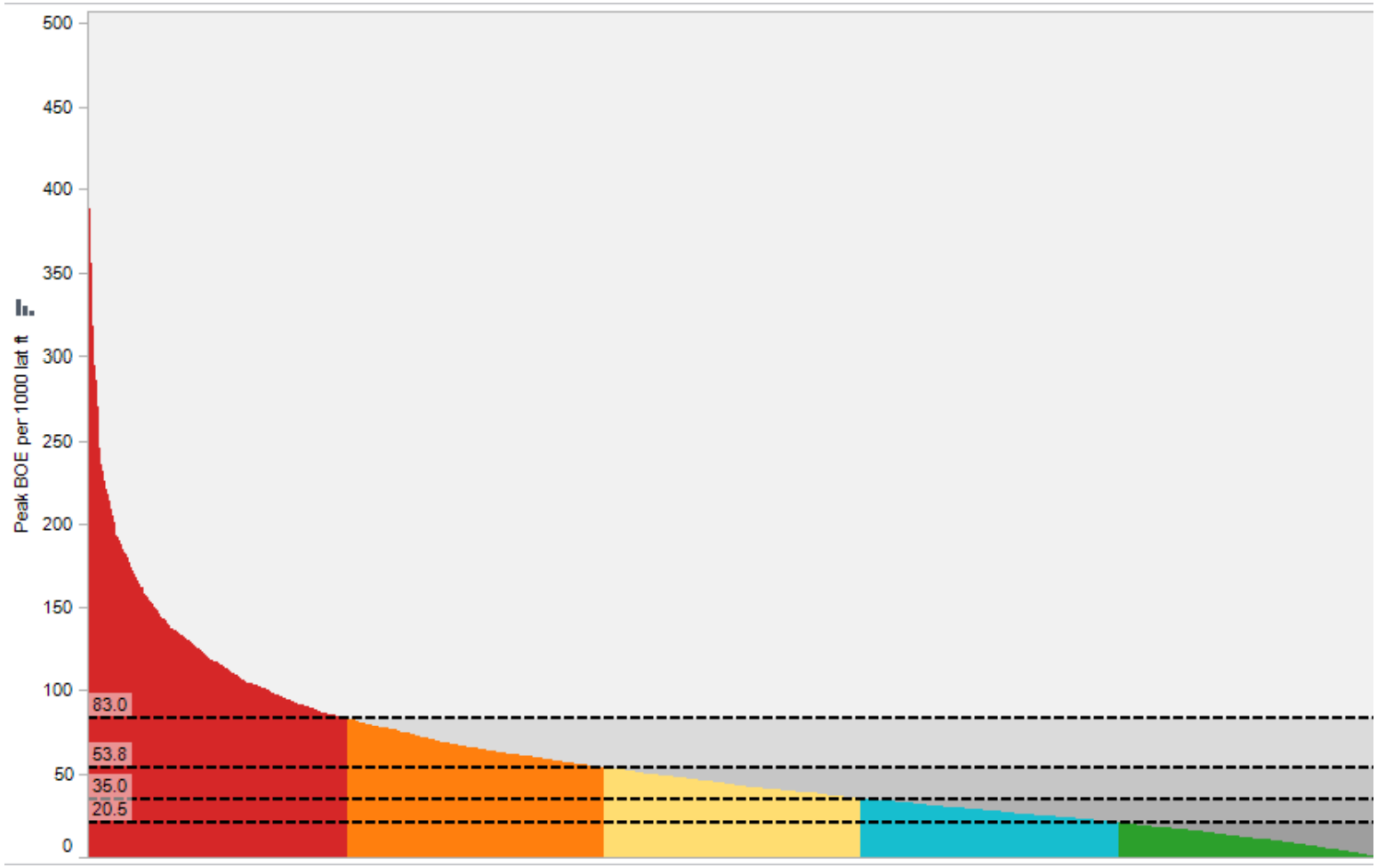
Plays Exhibit Widely Variable Results



The inherent variability of rock productivity is far larger than differences in cost structures or operational practices.

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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

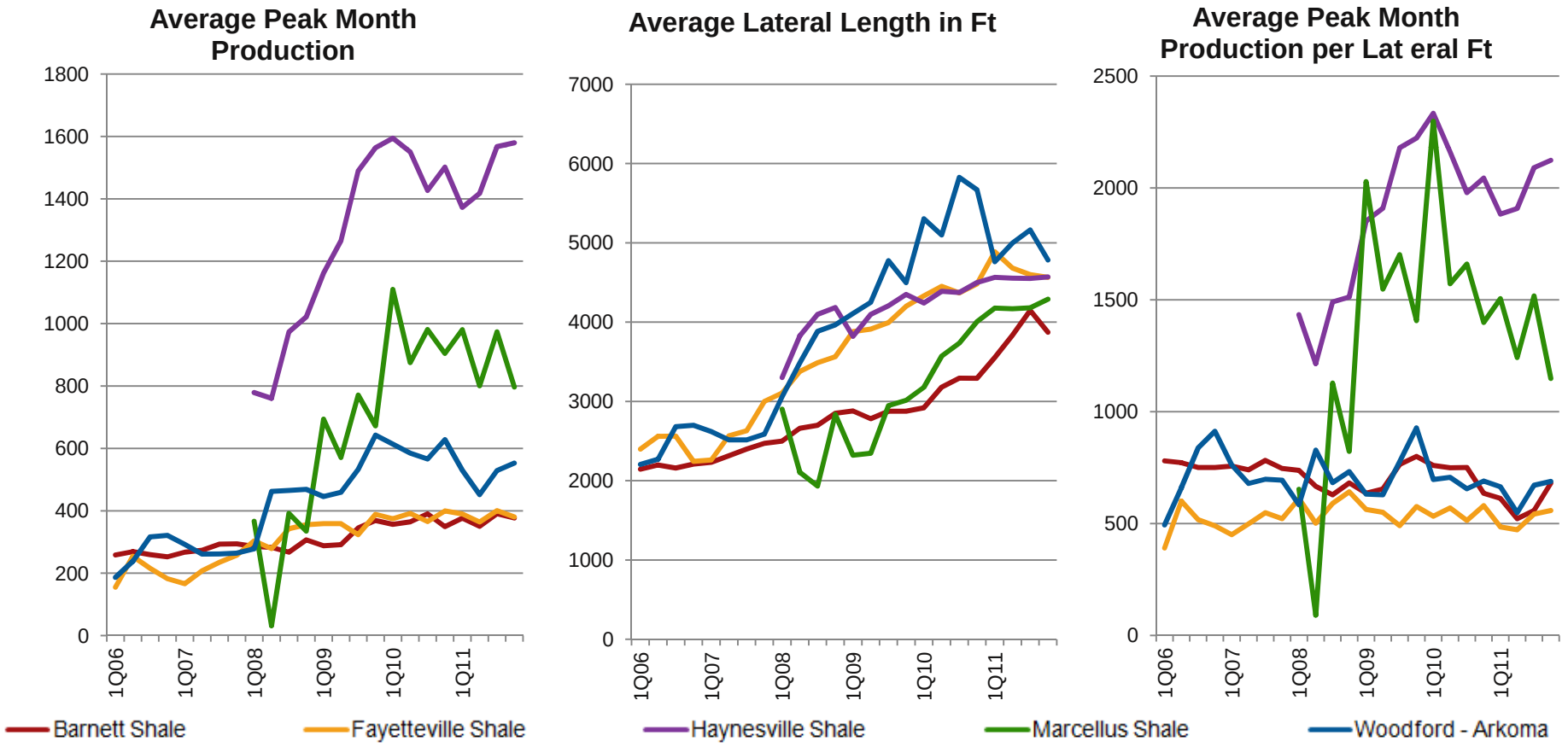
b) Steady improvements have pushed it up. 240

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.



Source: PFC Energy, DrillingInfo, State databases

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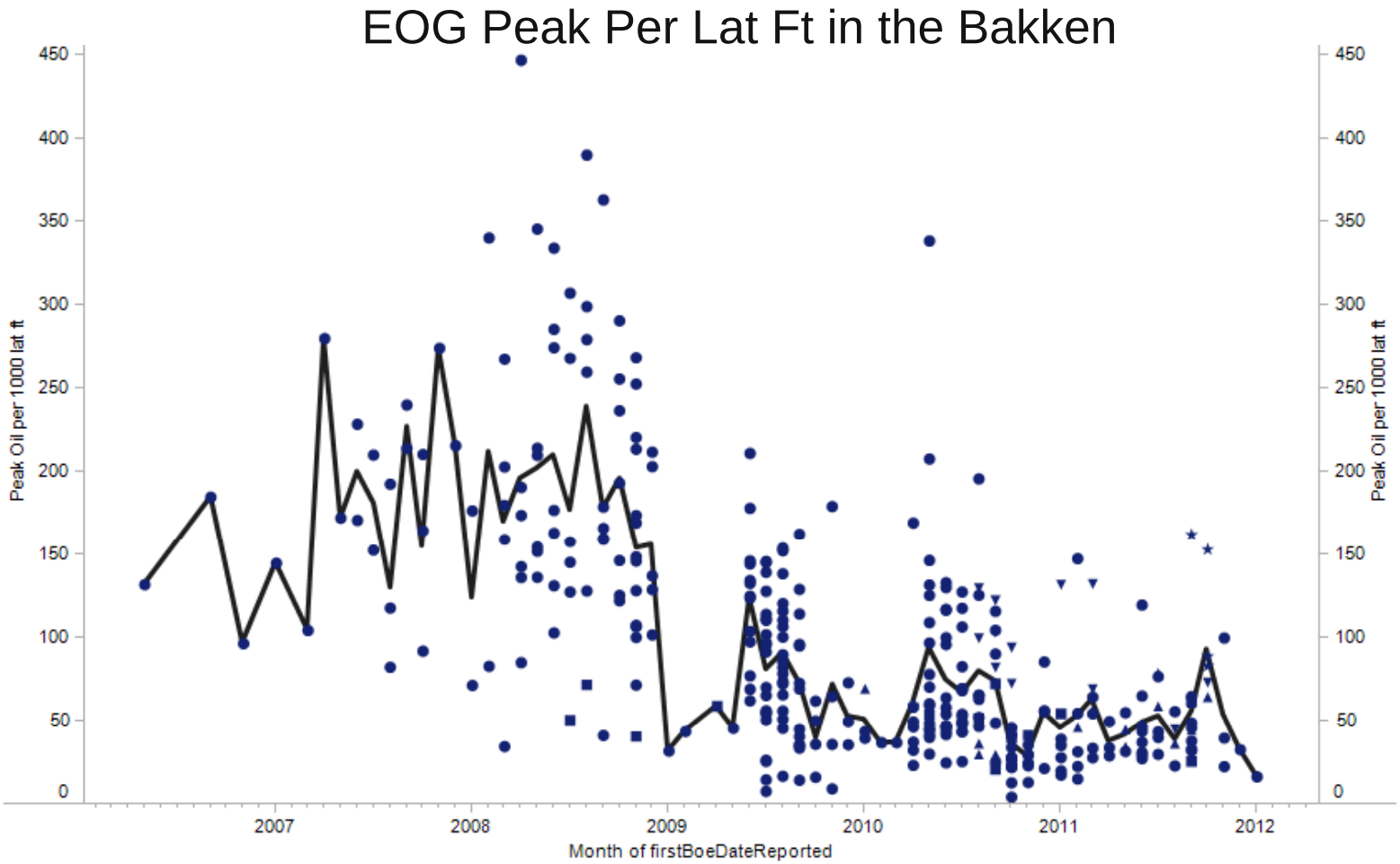
Eating the Power Bars and Leaving the Popcorn?



Companies rightly seek to exploit the sweet spots first, but this leads over time to quality degradation in the play unless technology leaps forward.

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Question 6: Life in the Basement

- No one should be drilling in the Haynesville today. The play is uneconomic.

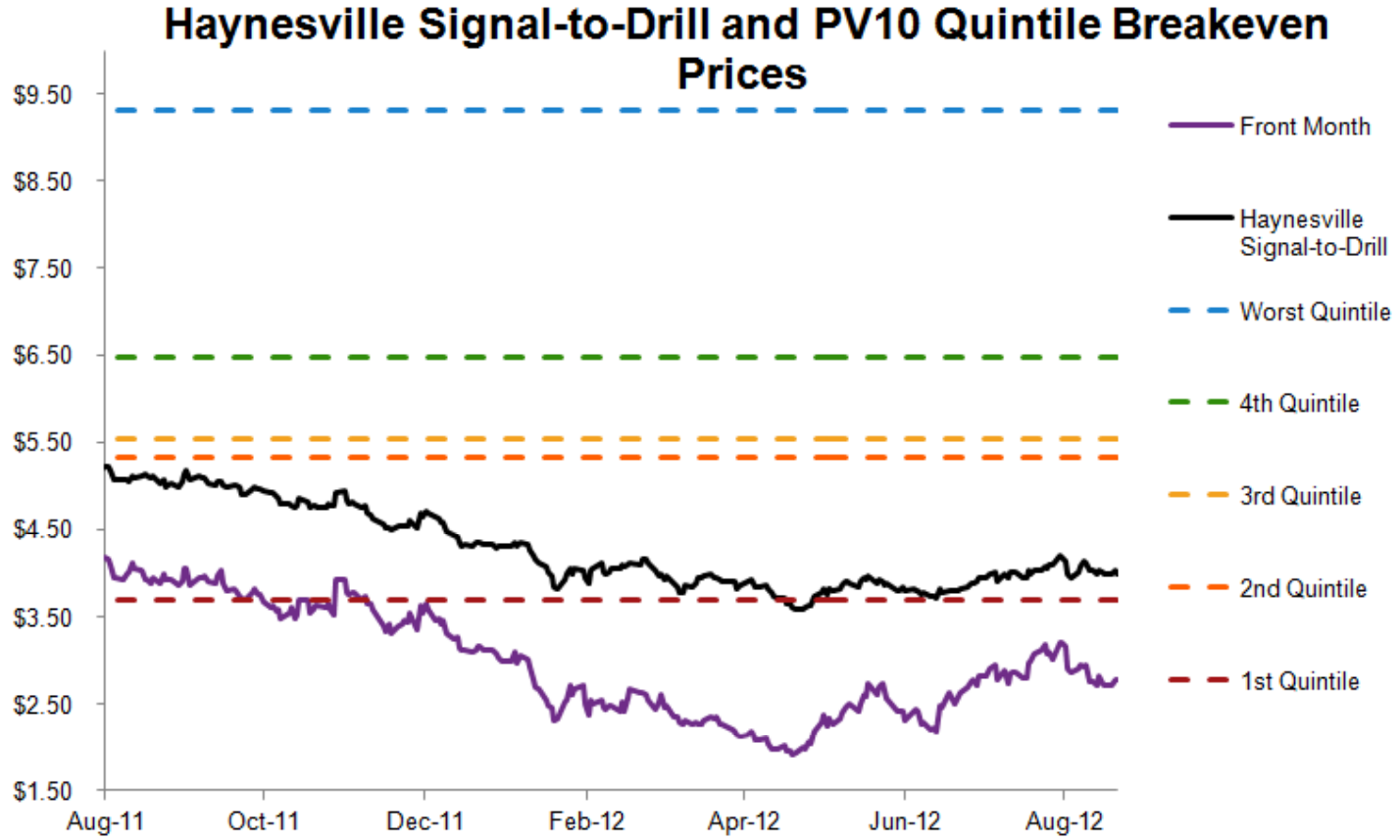
a) True. Those guys are setting money on fire.

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.



Source: NYMEX, PFC Energy, DrillingInfo, State databases

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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 in 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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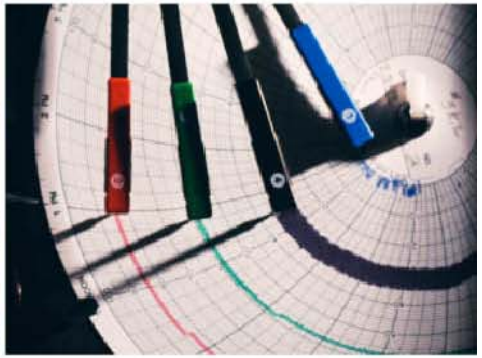

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