**Risk Analysis for Unconventional Resource Opportunities***

By

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**Abstract**

A decidedly different approach must be taken for risk analysis (chance and uncertainty) in unconventional opportunities. Due to the non-applicability of field size distributions (FSD’s), a new approach to range-based resource estimation involving multiple well size distributions (WSD’s) is warranted. Single WSD evaluation methods are inherently flawed resulting in gross error, inclusion of significant bias (usually upside), and poor development decisions. Uncertainty envelopes for both resource and production potential form the starting point for evaluation. As seen in a typical Shale Gas project, the impact on NPV of resource uncertainty is greatly reduced from that of conventional opportunities, whereas, production and cost uncertainty have significantly increased impact. Unconventional assessments should provide guidance as to the certainty of making a correct decision as opposed to simply calculating a mean or deterministic result on a risked or success basis. Valid opportunity assessment is enabled through a full value-chain approach that helps make land, pilot, and development decisions in a timely and effective manner.
Risk Analysis for Unconventional Resource Opportunities

Bill Haskett
AAPG - April 21, 2008

CONFIDENCE THROUGH CLARITY
Conventional seemed straight-forward…

...but no longer applies
In Unconventional, the area of potential is usually big.

The collection of spacing units forms a “Pseudo-Field”
Conventional uses Field Size Distributions

But remember… each field is a collection of wells… or spacing units
Meet the Well Size Distribution

Every field has a family of wells.
Good wells… and bad wells
But even Well Size Distributions Have Problems

There is no uncertainty when the wells are aggregated!

Even though it has a distribution, it only has one mean... so
The Correct Approach is an Envelope

An unconventional opportunity will have a resource unit distribution someplace in between the bounds
Envelopes are important for both Resource and Production

Correlation of Resource to IP implies an IP envelope is needed
Resource assessment forms the foundation but there is much more...

Contribution to NPV Uncertainty*

- **Resource**: 67%
- **Production**: 15%
- **CAPEX**: 18%

*Typical Gas Shale Play*
Work on What Matters
A decision centric approach provides a better assessment

• Create a Learning Plan
  – Pilot objectives
  – Production testing
  – Capital Efficiency

• Recognize what would change your decision

• Ensure Project Management Skills
  – Are in place
  – Are appropriate for Learning and Factory phases
Ultimately we must make our decisions based on a Full Value-Chain approach.

Full Project NPV versus Average EUR

![Graph showing the relationship between NPV (in $MM) and EUR (BCGF). The graph indicates uncertainty in profitability with a yellow box labeled "Uncertain Profitability." The x-axis represents EUR (BCGF), ranging from 1.00 to 3.50, and the y-axis represents NPV ($MM), ranging from ($150) to $150. The graph includes a trend line and several data points, with a particular focus on the area where profitability is uncertain.]
Full value chain allows you to manage Pilot, Land, and Rig decisions

How much land and when?

How large a pilot program?

How many rigs and when?

It enables you to create an efficient Learning Plan
How many pilot wells are needed?

If these charts show the aggregate project result uncertainty, and the information that provided this prediction is correct, qualitatively, how many wells will you need to ensure you are making the correct profit oriented decision?
How many pilot wells do you drill?

<table>
<thead>
<tr>
<th>Pilot Effectiveness</th>
<th>Pilot Good Proj. Good</th>
<th>Pilot Good Proj. Bad</th>
<th>Pilot Bad Proj. Good</th>
<th>Pilot Bad Proj. Bad</th>
<th>Pilot Effective</th>
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<tr>
<td>1 well</td>
<td>61%</td>
<td>6%</td>
<td>31%</td>
<td>3%</td>
<td>64%</td>
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<td>2 wells</td>
<td>71%</td>
<td>6%</td>
<td>21%</td>
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<tr>
<td>3 wells</td>
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<td>4 wells</td>
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</table>

% outcomes that are full-cycle positive

91%

'Diminishing learning with additional drilling'

'Optimal' Wells
How much land do you secure before the pilot result is known?

- High early purchase risks stranding capital or direct loss from pilot failure
- Both Risk and Cost based optimization
- Potential competition reduces land availability for late acquisition
- Increased competition elevates price for late acquisition

What MUST you know??

Theoretical Economic Limit

Cost

Activity noticed

Initial entry into a calm area

Pilot production period

Pilot success seen

Availability

Time
Entry and development decisions

Exploration Success

P_g \rightarrow \text{Is there Resource?}

Pilot Success

P_p \rightarrow \text{Is it recoverable?}

Mid-Program Check

\rightarrow \text{Was the Pilot Truthful?}

Development Success

P_c \rightarrow \text{Is it profitable?}
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