Why Can’t I get my Reserves Right?

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RPS Energy
Outline

• Scene set
  – Infill Drilling
  – Small Developments
• Performance
• What’s going on?
• Best Practice Suggestions
Infill Drilling & Small Developments

- Many Companies have post investment review process for large developments (production, capex, schedule, value etc...)
- Variety of third party groups (IPA) also track large E&P projects
- Published data suggesting “in-general” Reserves growth for large fields
  - Dromgoole - Petroleum Geoscience 1997
  - Watkins – MIT, Aberdeen 2002
  - BUT ... changing Projects & Price!

- and the smaller stuff?
  - Mature north sea infill drilling
  - Small developments (1 – 5 wells)
• Mature infill drilling
• OR Small Developments (1-5 wells)
• Data at project approval level
• ~ 10 years of data
• ~ 85 wells ~ 40 “projects”
• Multiple
  – countries, operators, oil & gas, Sandstone & carbonates
• All offshore
Mix of single wells & programs

General trend to under deliver

STILL !!!

~ 65 % of forecast

4 dry holes in 40 infill wells ~ 10 %

Best fit slope

\[ y = 0.6525x \]

• General shortfall on average
• Some dry Holes not plotted
2P ratio vs wells in program

- Portfolio effect as anticipated
- More wells in program = less uncertainty
- Some outright “dry holes”
- no improvement with time?
- ratios generally below 1:0
- several recent dry holes
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Infill & Small Developments reserves shortfall
- pre / post drill 2P reserves ratio = 0.65
- “ad hoc” single well infill programs most fragile
- No trends by oil / gas / infill etc
- not getting any better ? (Petrel, Mepo,,,,,etc)
- Multi phase programs better (benchmarking ?)
- Many sub economic at sanction prices !

Should we continue to rely on commodity growth to rescue our projects ?
RPS Energy

• Historical Review of N Sea Fields
  • Mainly oil fields
  • note data is metric

• Weak + trend with field size
• Range – 50 % to + 190 % !

• Small field smaller (on average)
• Big field bigger (on average)

<table>
<thead>
<tr>
<th></th>
<th>P10</th>
<th>P50</th>
<th>P90</th>
<th>n</th>
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<tbody>
<tr>
<td>all</td>
<td>0.48</td>
<td>1.17</td>
<td>2.9</td>
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</table>
Life-of-Field Reserves Changes: Observations

- Historical Uncertainty ranges
  - All data P10 – P90  - 50 % to + 190 %
  - Small fields P10 – P90  - 70 % to + 90 %
  - General ranges seen at sanction +/- 25 to 40 %?

- Big fields generally get bigger / small generally smaller .... WHY?

<table>
<thead>
<tr>
<th>Stage</th>
<th>Big Field (&gt; 100 mmboe)</th>
<th>Small Field (&lt; 50 mmboe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPRAISAL</td>
<td>Appraised to commerciality threshold not full potential (undrilled Fault Blocks / Horizons)</td>
<td>Often under appraised (economics won’t support)</td>
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<tr>
<td>DEVELOP</td>
<td>Sanction Optimization stops early as assets meet economic thresholds easily</td>
<td>Drive to meet economic targets lead to reserves &amp; value creep above true P50</td>
</tr>
<tr>
<td>OPERATE</td>
<td>Often Platform based - lower cost infill opportunities</td>
<td>Often Subsea – higher well intervention cost Hard to recover</td>
</tr>
<tr>
<td></td>
<td>Rich data base allows good model calibration</td>
<td>Reservoir Models never really mature to be robust</td>
</tr>
<tr>
<td></td>
<td>Robust to well failures / multiple wells in a reservoir offset drainage</td>
<td>Small well count – fragile to well failures</td>
</tr>
<tr>
<td></td>
<td>Longer field life – rising commodity price backdrop / technology development – time to learn &amp; optimize ..</td>
<td>Short Field life – missed opportunities – only 1 chance !</td>
</tr>
</tbody>
</table>
• Chapter 7 of -------------->
• System 1 / System 2
  – Intuitive / reasoning
• Availability (Vividness)
• Anchoring
• Overconfidence
• Group Bias
Example  Are the blocks A & B different OR the same colour?
Outline

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Best Practice Examples

• Scenario Modelling – Infill Wells
  – Was the HC ever there (reservoir, charge) ?
  – Is it there now ? (depletion & sweep) ?
  – Is it going to be productive at economic rates ?
  – Try to isolate the relevant uncertainty ?

• Manage risk & downside ?

• Embrace PEER Review

• Benchmarking (easy / quick / free ish !?)

• Reflect on unnecessary complex workflows

• Determine min , max then base …not base plus minus …. 

• Watch out for small fields & single well programs with no benchmark

• Watch out for behavioural bias…. Think how you ask questions !!!

• Organizations need to Value a good NO decision