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Integrating Reserves and Resource Assessment with Portfolio Management - A Hybrid Approach

John Etherington
Petroleum Resource Analysts (PRA) International Ltd., Calgary, Canada
Are reserves disclosures an isolated and bureaucratic process in your company?

Do you need two “sets of books” to run your business?

Are your managers (and investors) frustrated with reserves write-downs?
Outline

Introduction

Management Processes and Tools

Designing an Integrated System

Summary & Conclusions
E&P Business Model

We are in the hydrocarbon finding, developing and producing business!

E&P Life Cycle

Prospect Generation

Wildcat Drilling

Discovery, Appraisal, Development

Field Optimization

Enhanced Recovery

Decline, Abandonment
Resource Assessment Process

Consistent assessments lead to:
- Prospects
- Discoveries
- Development Projects

Uncertainty and Risk
- Discovery Risk
- In-Place Uncertainty
- Commercial Risk
- Recovery Uncertainty
- Commercial Uncertainties

Estimated Ultimate Recoverable (EUR)

Volume

Value

Net Present Value (NPV)
Resource Tracking & Reporting

Exploration Discoveries

Acquisitions and Sales

Reserves Disclosures are a subset of the total resource accounting.

Resource Accounting System

total portfolio debits and credits plus internal

“reserves growth”
Portfolio Management Tools

full reserve & resource “opportunity inventory”

quantitative assessments of risk & uncertainty [probabilistic-based]

Corporate Strategies

Investment Portfolio

$ Allocation Model

Aggregation Model

Portfolio Performance
Designing a HRM System

- promote **consistent** assessment processes
  - quantify technical uncertainties & commercial risk
  - synchronize volume and value
- accommodate **complete** project inventory
- accept **deterministic and/or probabilistic** methods
- avoid “two sets of books”

We need a single **Integrated** system
Resource Management Data Model

synchronizing volume, value and ownership at the “entity level”

Reservoir (in-place)

Lease (ownership)

Project (cash flow)

Reserves Disclosures

Portfolio Analysis

aggregation

applications
Standard Resource Classification

<table>
<thead>
<tr>
<th>Discovered</th>
<th>Undiscovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-commercial</td>
<td>Low Estimate</td>
</tr>
<tr>
<td>Commercial</td>
<td>Best Estimate</td>
</tr>
<tr>
<td>Proved</td>
<td>High Estimate</td>
</tr>
<tr>
<td>Probable</td>
<td>RESERVES</td>
</tr>
</tbody>
</table>

SPE/WPC/AAPG
2000
Reserves & Resource Classification

provides a “bridge” between deterministic & probabilistic methods

Technical Uncertainty
Quantifying Project Risk

- **Reserves**: [Chance of Achieving Production Status within 5 years]
- **Contingent Resources**: Discovered but not yet commercial due to one or more contingencies
- **Prospective Resources**: [Chance of Discovering Hydrocarbons]
- **Development Risk**
- **Discovery Risk**
Quantifying Acquisition Risk

Total Risk = acquisition risk x discovery risk x development risk
Two Views of Uncertainty

Deterministic View

- Cum Prod
- Proved
- Probable
- Possible
- EUR
do both! (hybrid)

Probabilistic View

- % probability of value or more
- P90
- P50
- P10
- Proved
- Probable
- Possible
- EUR
- cum prod
- 1P
- 2P
- 3P

Discrete Scenarios

Monte Carlo Simulation
Using Hybrids for Quality Assurance

Intercept at P80 vs >P90 target! There is a “mismatch” in our uncertainty analysis!

Probabilistic

Check both

Deterministic

Estimated Ultimate Recoverable (EUR) mmbo
Integrate deterministic estimates with probabilistic distribution to derive average confidence factors (CF).

- Proved: 17 (CF1 = 0.95)
- Probable: 27 (CF2 = 0.74)
- Possible: 56 (CF3 = 0.28)

Estimated Ultimate Recoverable (EUR): 1P = 17, 2P = 44, 3P = 100

Ev (mean) = 52 = 17 (.95) + 27 (.74) + 56 (.28)
Creating “Pseudo-Distributions”

Using default confidence factors (CF):

\[ EV \text{ (Mean)} = Pvd(0.95) + \text{Prob}(0.7) + \text{Poss}(0.3) \]

“Probabilistic”

default CF values based on local calibration tests
Integrating Regulatory Disclosure Rules

e.g. “SEC Proved” reserves

- Discovery Criteria
- Economic Criteria:
- Volume Extent:
- Improved Recovery

more conservative deterministic criteria?

SEC Proved

SPE/SEC Hybrid

SPE 2P minus SEC Proved = revised SPE Probable
Hybrid Assessments – Input/Output

Probabilistic assessment

deterministic assessment

Volume
Confidence Factor
Discounted Volume

<table>
<thead>
<tr>
<th>Proved</th>
<th>Probable</th>
<th>Possible</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>.95</td>
<td>16</td>
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<tr>
<td>27</td>
<td>.74</td>
<td>20</td>
</tr>
<tr>
<td>5 6</td>
<td>.28</td>
<td>16</td>
</tr>
</tbody>
</table>

Mean = 52

Continuous distribution

Commercial risk

Probabilistic &/or deterministic applications

Discretized matrix

Mean = 52
Resource Accounting/Material Balance

Initially-In-Place = Produced + Remaining “Recoverable” + Unrecoverable

Produced

5

Remaining “Recoverable”

55

Unrecoverable

40

= Initially-In-Place

100

sales and non-sales quantities

Reserves

Economic & Committed

5

Economic -Not Committed

20

Economic?? -Not Committed

10

Contingent Resources

Primary

Waterflood

EOR
development projects

mean of distributions
Resource Tracking & Reporting

Reconcile changes to maintain material balance

Prospective Resources
New Field Discoveries
Acquisitions
Property Sales
Production
Sales

Possible
Probable
Proved
C. Resources
Reserves
Undev → Dev

Reconcile changes to maintain material balance
Probabilistic vs Arithmetic Aggregation

- **Estimated Ultimate Recoverable (EUR) mmbo**
- **P10**
- **P90**
- **P90 = 30**
- **Cumulative Probability of “X” or greater**
- **Probabilistic Aggregate**
- **Arithmetic Sum (deterministic)**
- **“portfolio effect”**
- **EV**
- **Probabilistic**
- **Arithmetic**

- **reserves disclosures**
- **portfolio analysis**
Summary

The key is the data model.
“Project” synchronizes volume and value.

SPE classification provides a standard framework.
Modifications quantify commercial risk.

Hybrid methods quantify technical uncertainty for resource accounting & portfolio management.

Resource management teams ensure corporate-wide assessment consistency and quality.
Hydrocarbon Resource Management System

Integrated QA/QC

Hybrid Resources Assessments

There is only one set of books!

Project Database

Portfolio Management

Resource Tracking And Reporting

reserves disclosures
You now have a happy manager!
Key References

SPE Reserve and Resource Definitions and Glossary (www.spe.org)

Guidelines for Evaluation of Petroleum Reserves & Resources (SPE 2001)


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