„Evaluation and Classification of Hydrocarbon Resources“

Workshop “Mining the Technosphere”
Institute for Water Quality, Resource and Waste Management

Vienna University of Technology
Vienna, October 1\textsuperscript{st}, 2015

Martin Hubbig, OMV Exploration & Production
Warm up

Example 1: You are driving a car
- Fuel indicator lights up → Fuel for 100 km left
- You drive another 50 km without finding a gas station
- How much is left? 50 km, correct!

Example 2: You are producing oil
- Oil reserves @ year end 2014: 1700 bill barrel\(^1\)
- Production 2015 exp.*\(^2\): 88.7 mio bbl/d = 32.4 bill bbl/year
- → R/P rate = 53 years → Out of reserves in 2068
- Next workshop on Technospheric Mining in 3 years (2018)
- Out of reserves in 2068 → 50 years?
- No, wrong! R/P rate still 53 years, out of reserves in 2071

*\(^1\) BP Statistical Review of World Energy, June 2015
Agenda

- Introduction
  - Stakeholder of Reserves Statements
  - International Standards
- Definitions and Classifications (Risk)
  - Terminology
    - Prospective Resources
    - Contingent Resources
    - Reserves
- Classification Systems
  - SPE Petroleum Resource Management System (PRMS)
  - OMV Reserves Resource Matrix
- Categorization (Uncertainty)
- Outlook, United Nations Framework Classification (UNFC 2009)
Stakeholder of Reserves Statements

- Governments – to manage their resources
- Financial community – to provide information necessary to allocate investment capital appropriately
- E&P companies
  - Internal: To provide data for the management for
    - Strategic decisions
    - Project planning
    - Budget allocation to reduce costs and increase profit
  - External: To meet reporting requirements for the host countries and serve shareholders and investment community
- Creators of international energy and mineral studies – to facilitate the formulation of consistent and far-sighted policies
International Standards/Classification Systems

- SORP, UK Statement of Recommended Practices (2001)
- RF, Russian Ministry of Natural Resources (2005)
- PRO, China Petroleum Reserves Office (2005)
- NPD, Norwegian Petroleum Directorate (2001)
- CRIRSCO (Committee for Mineral Reserves International Reporting Standards)
- SPE-PRMS (March 2007), harmonizing
  - SPE (Society of Petroleum Engineers)
  - WPC (World Petroleum Council)
  - AAPG (American Association of Petroleum Geologists)
  - SPEE (Society of Petroleum Evaluation Engineers)
- UNFC (United Nations Framework Classification)
Definitions and Classifications
Resource Classes

- Prospective Resources
- Contingent Resources
- Reserves
Prospective Resources

- This class covers undiscovered hydrocarbons in exploration prospects and leads. Unlike the other classes, prospects and leads have a risk that they do not contain hydrocarbons. Prospects and Leads need to be risked discounted.

- The definitions for prospects and leads are designed to highlight potential accumulations that can be quantified. They are expected to be drilled and therefore should be added to the asset base.

<table>
<thead>
<tr>
<th>Prospective Resources</th>
<th>Prospect</th>
<th>A project associated with a potential accumulation that is sufficiently well defined to represent a viable drilling target.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lead</td>
<td>A project associated with a potential accumulation that is currently poorly defined and requires more data acquisition and/or evaluation in order to be classified as a prospect.</td>
</tr>
<tr>
<td></td>
<td>Play</td>
<td>A project associated with a prospective trend of potential prospects, but which requires more data acquisition and/or evaluation in order to define specific leads or prospects.</td>
</tr>
</tbody>
</table>
Contingent Resources

Contingent Resources are discovered and potentially recoverable quantities that are, currently, not considered to satisfy the criteria for commerciality.

<table>
<thead>
<tr>
<th>Contingent Resources</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development Pending</td>
<td>A discovered accumulation where project activities are ongoing to justify commercial development in the foreseeable future.</td>
</tr>
<tr>
<td>Development Unclarified or on Hold</td>
<td>A discovered accumulation where project activities are on hold and/or where justification as a commercial development may be subject to significant delay.</td>
</tr>
<tr>
<td>Development Not Viable</td>
<td>A discovered accumulation for which there are no current plans to develop or to acquire additional data at the time due to limited production potential.</td>
</tr>
</tbody>
</table>
To be classified as Reserves, the quantities must be discovered, recoverable, commercial (i.e. the development project must satisfy OMV’s economic criteria) and remaining (i.e. not yet produced as at the date of the estimate). If the field is not already under development, it should be at least 90% certain that it will be placed on production within five years.

<table>
<thead>
<tr>
<th>Reserves</th>
<th>On Production</th>
<th>Approved for Development</th>
<th>Justified for Development</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The development project is currently producing and selling petroleum to market.</td>
<td>All necessary approvals have been obtained, capital funds have been committed, and implementation of the development project is under way.</td>
<td>Implementation of the development project is justified on the basis of reasonable forecast of commercial conditions at the time of reporting, and there are reasonable expectations that all necessary approvals/contracts will be obtained.</td>
</tr>
</tbody>
</table>
Proved – Probable – Possible

- **Proved Reserves (1P)** are those reserves that, to a high degree of certainty (90% confidence or P90), are recoverable from known reservoirs under existing economic and operating conditions. There should be relatively little risk associated with these reserves. A further sub-division distinguishes between proven developed reserves (reserves that can be recovered from existing wells with existing infrastructure and operating methods) and Proven undeveloped reserves (which require incremental development activity).

- **Proved + Probable Reserves (2P)** are those reserves that analysis of geological and engineering data suggests are more likely than not to be recoverable. There is at least a 50% probability (or P50) that reserves recovered will exceed the estimate of Proven plus Probable reserves. All told this is the level of oil that based on probability analysis is most likely to be recovered.

- **Proved + Probable + Possible Reserves (3P)** are those reserves that, to a low degree of certainty (10% confidence or P10), are recoverable. There is relatively high risk associated with these reserves. Reserves under this definition include those for which there is a 90% chance of recovery (proven), a 50% chance of recovery (probable) and up to a 10% chance of recovery (possible). Evidently, 3P reserves are the least conservative and, whilst ultimately 90% recovery may occur, from the outset the odds are that use of this measure will overstate the level of recovery.
## OMV Reserves/Resource Matrix

<table>
<thead>
<tr>
<th>Scenario/Category</th>
<th>Description</th>
<th>CoM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sold</strong></td>
<td>Depleted, sold HC, cumulative production</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Reserves</strong></td>
<td>Production</td>
<td>Sold</td>
</tr>
<tr>
<td><strong>Contingent Resources</strong></td>
<td>Approved for development</td>
<td>&gt;90%</td>
</tr>
<tr>
<td><strong>Tollgate 3</strong></td>
<td>Approved for development</td>
<td>&gt;70%</td>
</tr>
<tr>
<td><strong>Tollgate 2</strong></td>
<td>Justified for development -Project defined-</td>
<td>&gt;30%</td>
</tr>
<tr>
<td><strong>Tollgate 1</strong></td>
<td>Development Pending -Concept early stage-</td>
<td>&gt;0%</td>
</tr>
<tr>
<td><strong>Development Unclarified or On Hold -Technical Resources-</strong></td>
<td>Development not viable -Subeconomic, discovered-</td>
<td>0</td>
</tr>
<tr>
<td><strong>Prospective Resources</strong></td>
<td>Prospect</td>
<td>&gt;0%</td>
</tr>
</tbody>
</table>

### Notations
- **CoM**: Chance of Maturation
- **HC**: Hydrocarbon
- **CoM**: Contingent chance of maturation
- **FIRE/AFW**: Fire; AFW: Afrikanische und Ostafrikanische Wälder (African and Eastern African Forests)
- **MAR/OFW**: Maritime; OFW: Ostafrikanische Wälder (Eastern African Forests)

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Chance of Maturation

- Hydrocarbon Chance \( P_{hc} \)
  - Saturation/Porosity
  - Facies/Thickness
  - Movable HC´s

- Project Chance \( P_{tc} \)
  - Skills (resources, people)
  - Drilling/Construction
  - Facilities/Performance
  - Technology
  - Timing

- Recovery Chance \( P_{pc} \)
  - Drainage Volume
  - Sweep/displacement efficiency
  - Production method
  - Recovery Mechanism

- Commercial Chance \( P_{cc} \)
  - Social license to operate
  - Approval/Budget/Financing
  - HSE/Legal/Communities
  - Market/Price/Contracts

The Chance of Maturation CoM = \( P_{hc} \times P_{pc} \times P_{tc} \times P_{cc} \)
Categorization (Uncertainty)
Risk and Uncertainty

- Risk
  - Project Maturity: Will the project go ahead?

- Uncertainty
  - What is the range of estimated recoverable volumes, if the project does go ahead?
Uncertainty

No. Good engineering practice is applied.
But education, experience, preferences, interpretations and point of view of the QRE´s play a significant role.
Rabbit or Bird?

It’s a question of the perspective. There’s no right or wrong.
### Assessment of Words

<table>
<thead>
<tr>
<th>Expression</th>
<th>Range of Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quite certain</td>
<td></td>
</tr>
<tr>
<td>Expected</td>
<td></td>
</tr>
<tr>
<td>Likely</td>
<td></td>
</tr>
<tr>
<td>Probable</td>
<td></td>
</tr>
<tr>
<td>Not reasonable that</td>
<td></td>
</tr>
<tr>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>Hoped</td>
<td></td>
</tr>
<tr>
<td>Not certain</td>
<td></td>
</tr>
<tr>
<td>Doubtful</td>
<td></td>
</tr>
<tr>
<td>Unlikely</td>
<td></td>
</tr>
</tbody>
</table>

1 2 3 4 5 6 7 8 9 10

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Uncertainty in Volumetrics

\[ V = L \times B \times H \]

P50 (best)

\[ 30 \times 20 \times 5 = 3000 \]

P90 (low)

\[ 25 \times 15 \times 3 = 1125 \]

P10 (high)

\[ 35 \times 25 \times 8 = 7000 \]
Uncertainty Ranges

- VIP (Volume in Place) = Volume * Porosity
- Expected Ultimate Recovery EUR = VIP * Recovery Factor* (RF)

<table>
<thead>
<tr>
<th></th>
<th>Volumen</th>
<th>*</th>
<th>Porosität</th>
<th>*</th>
<th>RF</th>
<th>=</th>
<th>EUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>P50 (best)</td>
<td>3000</td>
<td>*</td>
<td>0,20</td>
<td>*</td>
<td>0,5</td>
<td></td>
<td>300,0</td>
</tr>
<tr>
<td>P90 (low)</td>
<td>1125</td>
<td>*</td>
<td>0,15</td>
<td>*</td>
<td>0,4</td>
<td></td>
<td>67,5</td>
</tr>
<tr>
<td>P10 (high)</td>
<td>7000</td>
<td>*</td>
<td>0,25</td>
<td>*</td>
<td>0,6</td>
<td></td>
<td>1050,0</td>
</tr>
</tbody>
</table>

*For simplicity reasons, permeability, water saturation, residual hydrocarbons, sweep efficiency, accuracy of data and interpretation of information is disregarded.
Uncertainty Ranges

Range of Uncertainty

- Discovery
- Appraisal
- Development Plan
- Start of Production
- Production
- Economic Limit

Time

Ultimate Recovery

- high
- best
- low

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Outlook: United Nations Framework Classification System (UNFC 2009)
United Nations Framework Classification

- What are the benefits of a global, unique system?
  - Effective management of limited resources in a globalizing economy requires accurate assessments of the supply base
  - Recoverable quantities must be described in a manner that is consistent with other scientific and social/economic information used in management and, in particular, in a manner that is consistent with the information describing the projects to recover them
  - A number of different standards have evolved over time in response to various professional needs and local requirements
  - There has been a natural progression of these standards towards the development of a common global standard, the UNFC
UNFC Fundamentals

- Generic principle-based system in which quantities are classified on the basis of the three fundamental criteria of:
  - Economic and social viability (E)
  - Field project status and feasibility (F)
  - Geological knowledge (G)

- Using a numerical and language independent coding scheme

- Combination of these criteria create a uniquely and simple applicable system
E axis
- Economic and social viability

F axis
- Field project status and feasibility

G axis
- Geological knowledge
OMV Production and Proved Reserves ye 2014

2P (proved+probable reserves) ye 2014: 1,813 mn boe
Thank you very much for your attention!

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