Overview of UNFC (2009) for Petroleum Resources

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UNFC-2009 for Petroleum

- **Why is petroleum different?**
- **Overlap between industries**
- **Application of UNFC to petroleum**
- **Conclusions**

Why Petroleum is different

- It is (usually) mobile, i.e., a fluid
- Reservoir pressure (fluid) continuity is usually more critical than geological/grade continuity
- The recovery factor is virtually always a major uncertainty
- It is usually located too deep to drill lots of core holes, so the in-place volume is also a significant uncertainty

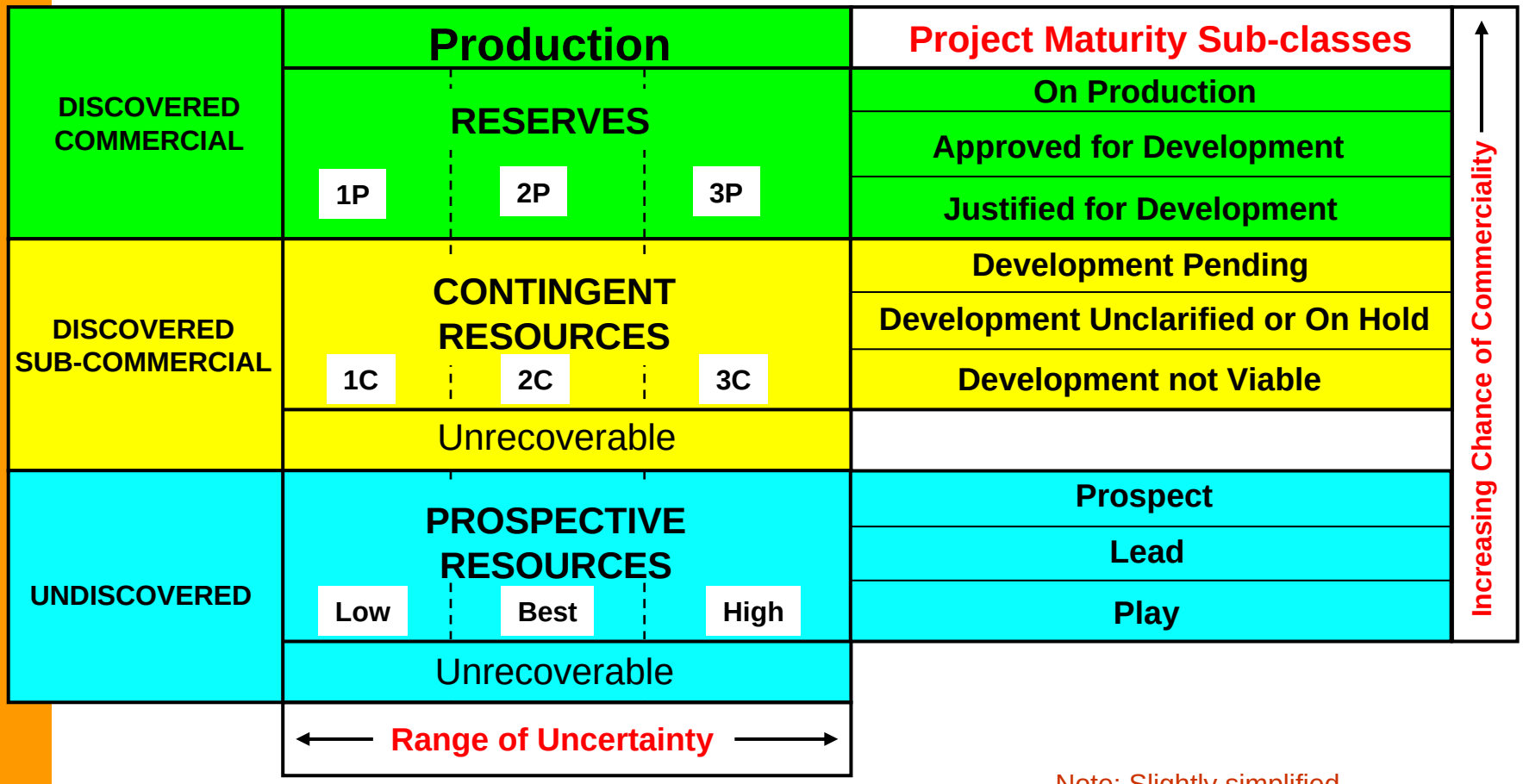
Why Petroleum is not different

- **Development of a deposit usually requires a very substantial initial investment commitment**
- **The extracted commodity usually needs to be processed on-site in order to have a saleable product**
- **Sales prices are volatile**
- **In some cases, minerals can be produced through wells and petroleum can be extracted by mining**

SPE-PRMS (2007)

- **Two-dimensional system**
  - **Level of Project Maturity**
    - **Characterised by the probability of the project achieving production and hence revenue**
  - **Range of Uncertainty**
    - **Characterised by the range of estimated recoverable (sales) volumes from the project**

SPE-PRMS (2007)



Note: Slightly simplified representation from original

SPE-PRMS (2007)

- **Range of Uncertainty**
  - **Because of recovery uncertainty, we cannot (usually) isolate a specific volume of probable reserves**
- **For a given development plan**
  - **We can estimate a range of in-place volumes based on well results and seismic data**
  - **We can estimate a range of recovery factors**
  - **We can combine these in terms of discrete scenarios or a full probabilistic analysis**

SPE-PRMS (2007)

- **Low/Best/High Case Scenarios**

1P = Proved Reserves

2P = Proved plus Probable Reserves

3P = Proved plus Probable plus Possible Reserves

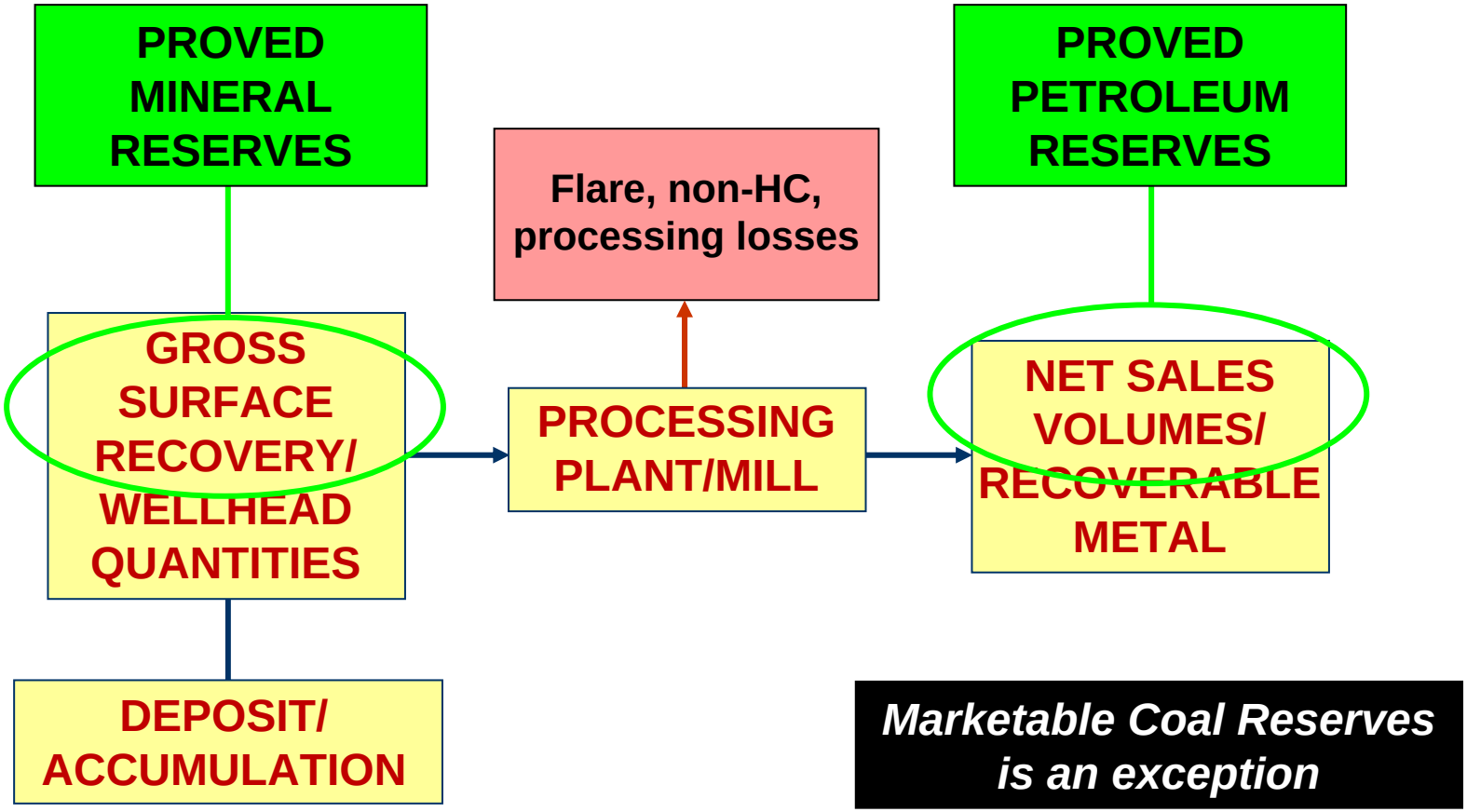
So are Mineral Reserves and Petroleum Reserves the same?

Are Mineral Reserves and Petroleum Reserves are the same?

	UNFC-2009	CRIRSCO (minerals)	SPE-PRMS (petroleum)
Known Deposit	Commercial Projects	Mineral Reserves	Reserves
	Potentially Commercial Projects	Mineral Resources	Contingent Resources
	Non-Commercial Projects	*Discovered Not Economic**	
	Additional quantities in place	*Discovered Unrecoverable**	Unrecoverable
Potential Deposit	Exploration Projects	Exploration Results	Prospective Resources
	Additional quantities in place	*Undiscovered Unrecoverable**	Unrecoverable

***Not part of the Template but may be used for internal project management**

Mineral Reserves vs. Petroleum Reserves



Mineral Reserves vs. Petroleum Reserves

Gold Reserves at Oyu Tolgoi (Mongolia)

	Tonnage (millions of tonnes)	Grade (grammes per tonne)	
Proved Ore Reserves (at end 2009)	127	0.93	
Probable Ore Reserves (at end 2009)	803	0.27	
Total Ore Reserves (at end 2009)	930	0.36	
Average Mill Recovery			71%
Rio Tinto share	Company Interest		19.7%
	Recoverable Metal (millions of ounces)		1.497

CRIRSCO
Proved Reserves

CRIRSCO
Proved + Prob. Reserves

PRMS
Proved + Prob. Reserves

Source: Rio Tinto, 2009 *Annual Report*, available at:
<http://www.riotinto.com/annualreport2009/pdf/productionandreserves.pdf>

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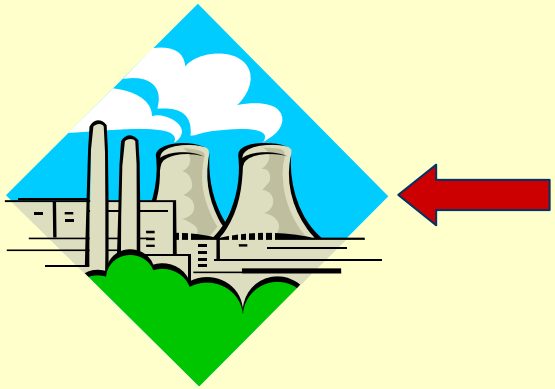
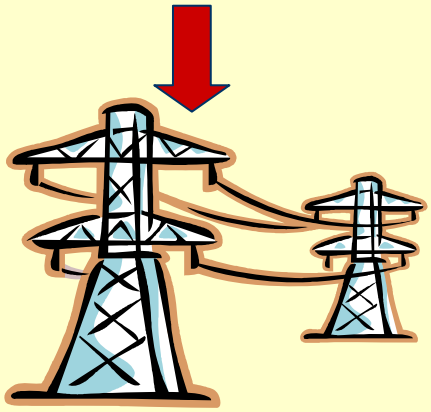
Coal mining: an oil & gas producing activity?





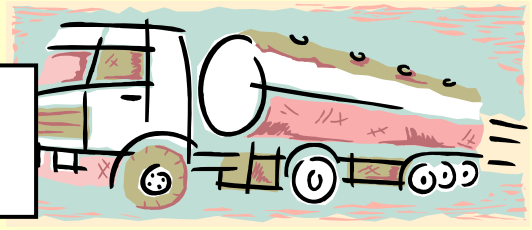
Coal sold for power generation

Mining disclosure and accounting rules

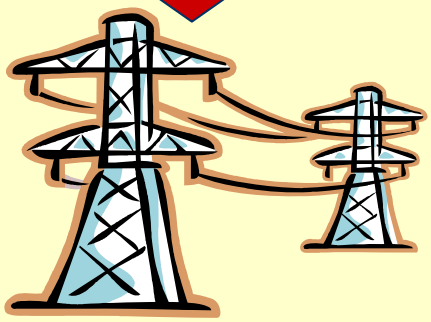
Coal mining: an oil & gas producing activity?

Coal sold for coal-to-liquids (CTL)

Oil & gas disclosure and accounting rules

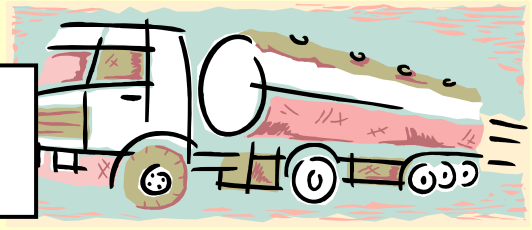


Coal mining: an oil & gas producing activity?



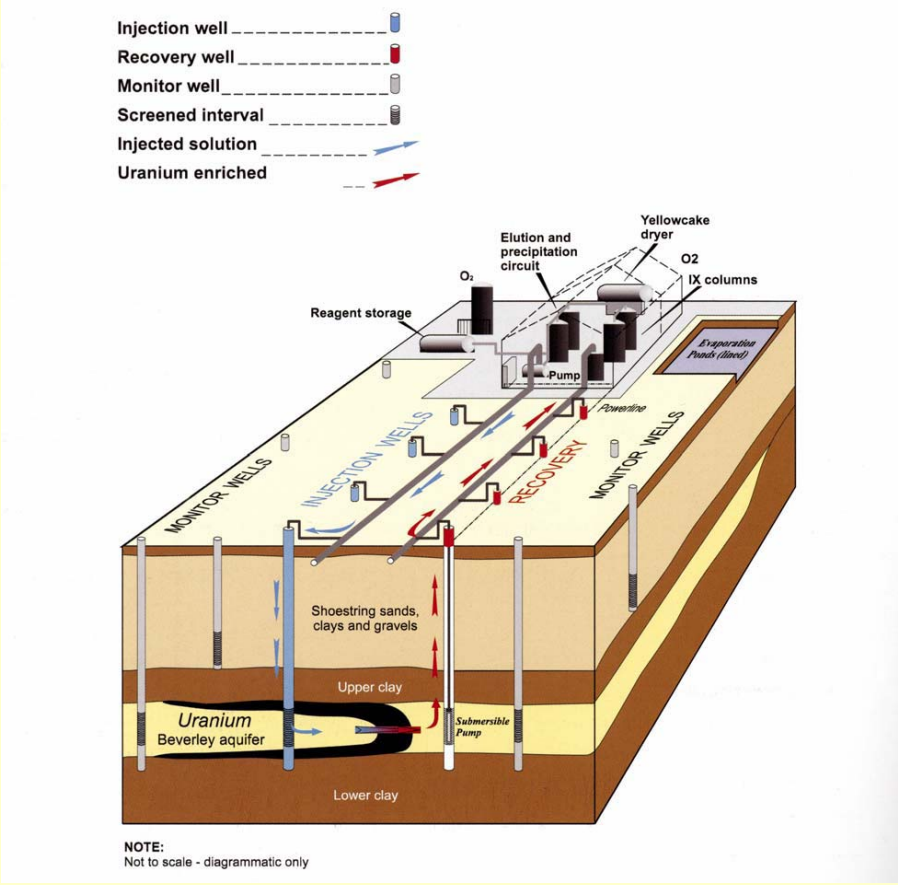
**Mining or Oil & Gas?
Or both?**

Which disclosure and accounting rules?



THE DISTINCTION BETWEEN INDUSTRIES IS NOT CLEAR

Uranium in-situ leaching: a mining activity?



Commercially producing uranium project

Looks like an oil & gas operation to me! Project would have reserves under PRMS

Mining Rules: NO RESERVES due to uncertainty in recoverable quantities

Schematic of in situ leach uranium mine (Heathgate Resources, 1999)

UNFC-2009 for Petroleum

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UNFC – E axis and F axis

- **UNFC, SPE-PRMS and NPD system are all project-based systems**
- **SPE-PRMS and NPD system combine E and F into "project maturity" categories**
- **UNFC provides additional granularity to distinguish between the primary reasons for different levels of maturity (i.e. economics versus feasibility)**
- **Correlation is straightforward**

UNFC – G axis

- **Level of confidence in the geological knowledge *and potential recoverability* of the quantities**

- **The uncertainty associated with the quantities estimated is communicated either by:**

  - **Quoting discrete quantities of decreasing level of confidence (high, moderate, low)**

  - **Generating three specific scenarios or outcomes (low, best and high)**

UNFC – G axis

- **Definitions of the G axis categories are the same for both solids and fluids**

- **The supporting explanation, however, describes how to apply these definitions to solid resources and fluids:**

  - **For resources extracted as solids, estimated project recovery for each class comes from a specific part of the deposit**

  - **For resources extracted as fluids, estimated project recovery reflects draining the accumulation as a whole**

UNFC – G axis

Category	Definition	Supporting Explanation (1)
G1	Quantities associated with a known deposit that can be estimated with a high level of confidence.	For in situ (in-place) quantities, and for recoverable estimates of fossil energy and mineral resources that are extracted as solids, quantities are typically categorised discretely, where each discrete estimate reflects the level of geological knowledge and confidence associated with a specific part of the deposit. The estimates are categorised as G1, G2 and/or G3 as appropriate.
G2	Quantities associated with a known deposit that can be estimated with a moderate level of confidence.	
G3	Quantities associated with a known deposit that can be estimated with a low level of confidence.	

UNFC – G axis

Category	Definition	Supporting Explanation (2)
G1	Quantities associated with a known deposit that can be estimated with a high level of confidence.	For recoverable estimates of fossil energy and mineral resources that are extracted as fluids, their mobile nature generally precludes assigning recoverable quantities to discrete parts of an accumulation. Recoverable quantities should be evaluated on the basis of the impact of the development scheme on the accumulation as a whole and are usually categorised on the basis of three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.
G2	Quantities associated with a known deposit that can be estimated with a moderate level of confidence.	
G3	Quantities associated with a known deposit that can be estimated with a low level of confidence.	

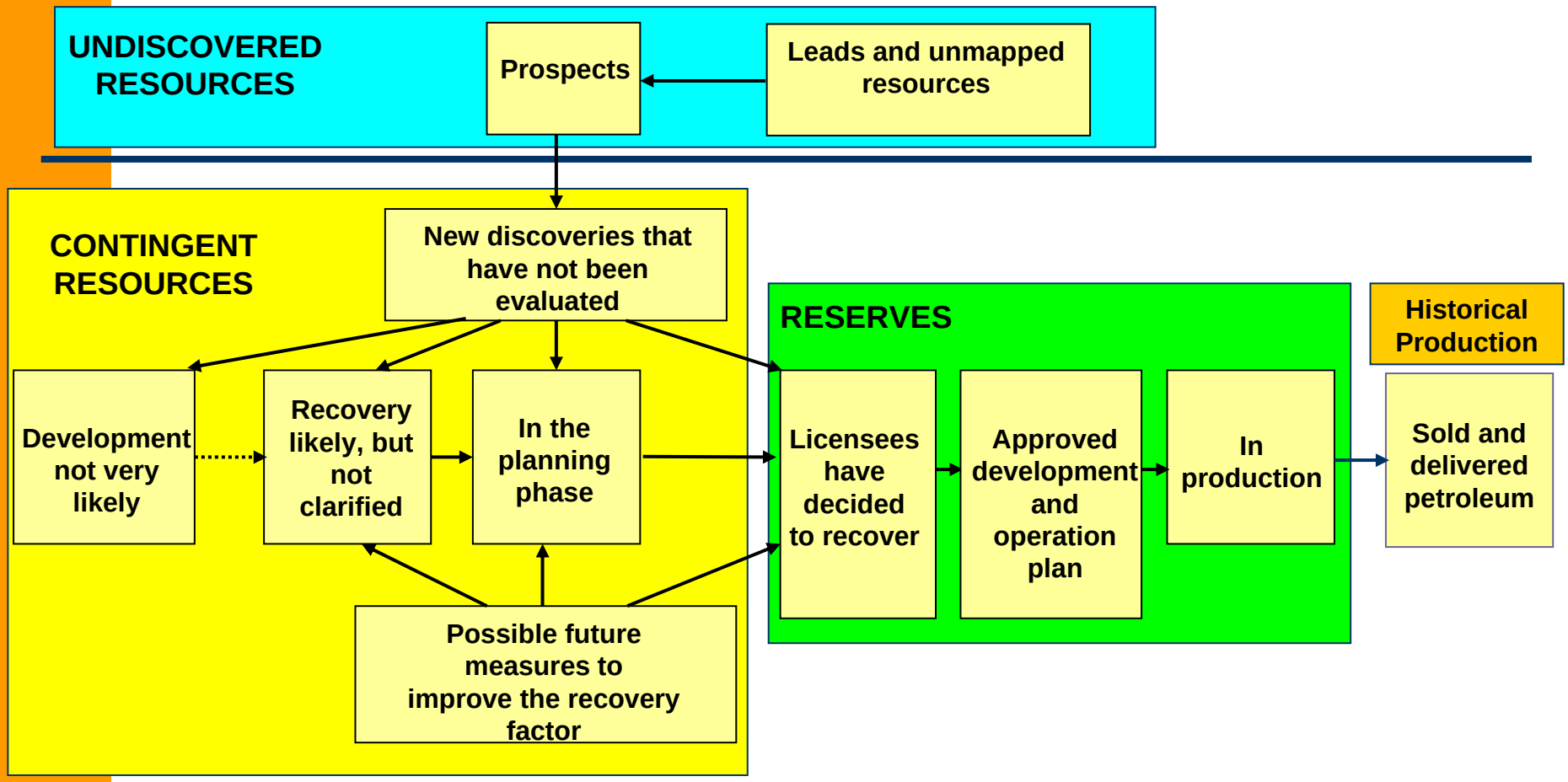
UNFC – Commercial Projects

- **Must be E1 and F1, can be G1, G2 and/or G3**
- **For solids:**
  - **High confidence estimate = 111**
  - **Moderate confidence estimate = 112**
  - **Low confidence estimate = 113**
- **For fluids:**
  - **Low estimate scenario = 111**
  - **Best estimate scenario = 111+112**
  - **High estimate scenario = 111+112+113**

Application of UNFC to Petroleum

- **Project undertaken by Norwegian Petroleum Directorate (NPD)**
- **Norway's petroleum resources are classified according to NPD's own reporting system**
- **NPD mapped the national petroleum resource base to UNFC-2009**

Norwegian Petroleum Directorate (2001)



NPD Aggregated Resource Account 2008 mapped to UNFC (source: NPD)

UNFC - 2009					NPD 2001		
Sales Production							Sales Production
Non-sales production							
Class	Sub-class	E	F	G	Category		Class
Commercial Projects	On production	1	1,1	1, 2, 3	In production	1	Reserves
	Approved for Development	1	1,2	1, 2, 3	Approved PDO	2 F/A	
	Justified for Development	1	1,3	1, 2, 3	Licencees decided to recover	3 F/A	
Potentially Commercial Projects	Development pending	2	2,1	1, 2, 3	In the planning phase	4 F/A	Contingent Resources
	Development on hold	2	2,2	1, 2, 3	Recovery likely but undecided	5 F/A	
Non-Commercial Projects	Development unclarified	3,2	2,2	1, 2, 3	Not yet evaluated	7 F/A	
	Development not Viable	3,3	2,3	1, 2, 3	Recovery not very likely	6	
Additional quantities in place		3,3	4	1, 2, 3			
Exploration Projects	No sub-classes defined	3,2	3	4	Prospect	8	Undiscovered resources
					Lead and Play	9	
Additional quantities in place		3,3	4	4			

NPD Aggregated Resource Account 2008 mapped to UNFC (source: NPD)

UNFC - 2009					NPD per 31.12.2008	NPD 2001		
					MSm^3 o.e.			
Sales Production					5055			Sales Production
Non-sales production								
Class	Sub-class	E	F	G		Category		Class
Commercial Projects	On production	1	1,1	1, 2, 3	2634	In production	1	Reserves
	Approved for Development	1	1,2	1, 2, 3	490	Approved PDO	2 F/A	
	Justified for Development	1	1,3	1, 2, 3	283	Licencees decided to recover	3 F/A	
Potentially Commercial Projects	Development pending	2	2,1	1, 2, 3	561	In the planning phase	4 F/A	Contingent Resources
	Development on hold	2	2,2	1, 2, 3	590	Recovery likely but undecided	5 F/A	
Non-Commercial Projects	Development unclarified	3,2	2,2	1, 2, 3	418	Not yet evaluated	7 F/A	
	Development not Viable	3,3	2,3	1, 2, 3	N/A	Recovery not very likely	6	
Additional quantities in place		3,3	4	1, 2, 3	N/A			
Exploration Projects	No sub-classes defined	3,2	3	4	3400	Prospect	8	Undiscovered resources
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Additional quantities in place		3,3	4	4	N/A			

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Conclusions

- **UNFC-2009 provides for a common language for classification and reporting, regardless of extraction methodology**
- **There is increasing overlap between the minerals and petroleum sectors**
  - **The two industry sectors (and the regulators) have yet to address this issue**
- **SPE and NPD petroleum systems are very well aligned with UNFC-2009 at a high level**
  - **NPD and Statoil are currently undertaking a very detailed mapping of the NPD system and UNFC-2009 to test for possible areas of ambiguity or inconsistency**

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