AleffGroup

“Comprehensive Extraction” and UNFC “S” – A new Social Contract between Stockholders and Stakeholders?

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Workshop on recent developments in evaluation of uranium and thorium resources

International Copper Study Group, Lisbon

15-18, October 2012

Agenda:
New Contract - New Equilibrium

1. "Comprehensive Extraction"…*Sustainable Development in Practice*

Goal: Defining – the terminology

2. Upgrading UNFC 2009 to UNFC "S" … *Necessary but not yet sufficient for "comprehensive extraction" …*

Goal: Mapping – the taxonomy, classes and metrics

3. The INT/2/015 Road Map: the *IAEA Expert Working Group's support role for MS in INT/ 2/015*
    1. Strategic/ policy options
    2. Technical assistance (technology selection, transfer and performance)
    3. Capacity building/ Ux professional network (now reaching critical mass)
    4. Policy development
    5. Regulatory requirements including safety, security, safeguards
    6. Social licensing

Goal: Sustaining – the returns and the risks (Triple Bottom Line, Economic, Social, Environmental)

UNFC “S”

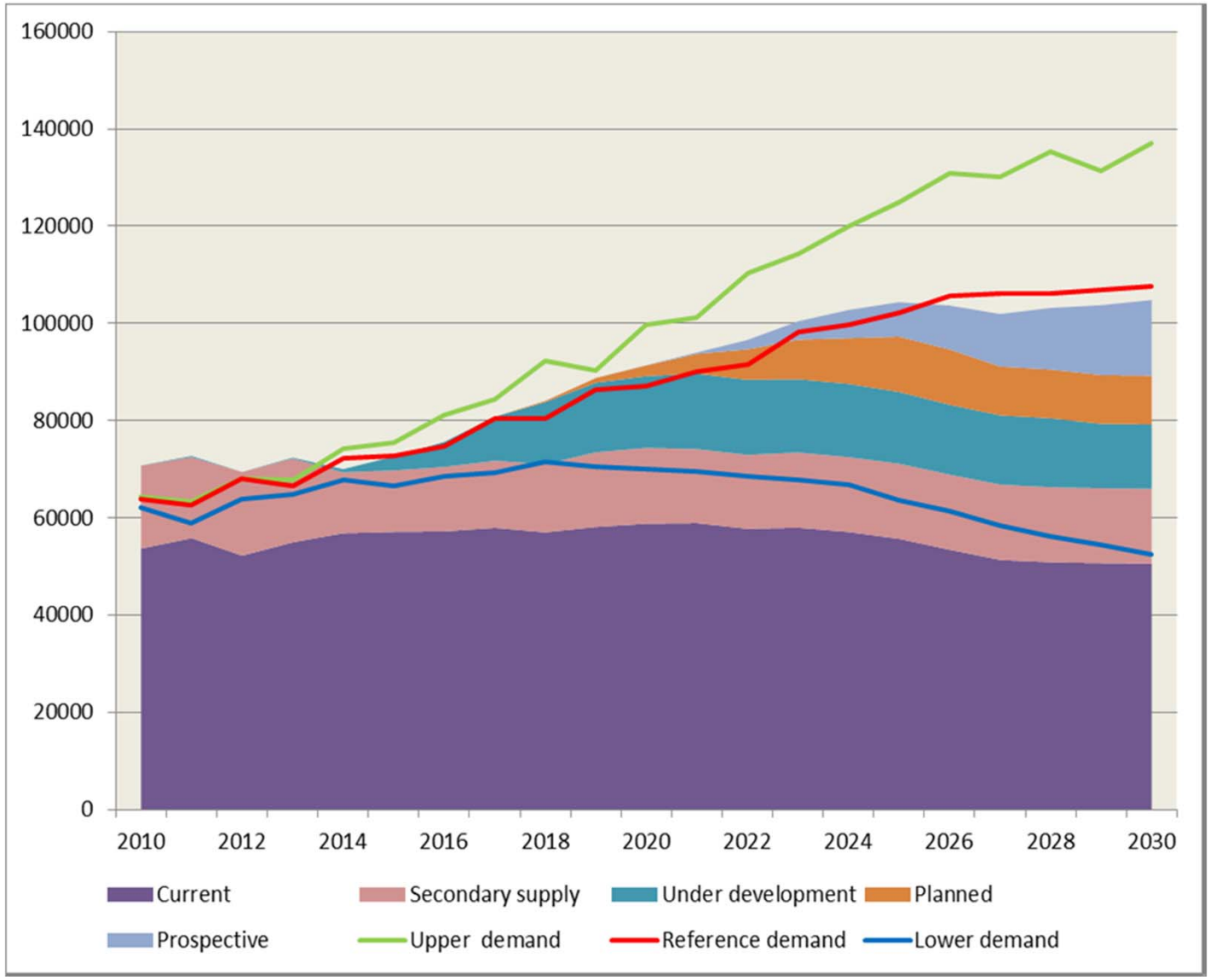
Equitable returns for both Stakeholders and Stockholders based on a renegotiated social contract

1. Comprehensive extraction

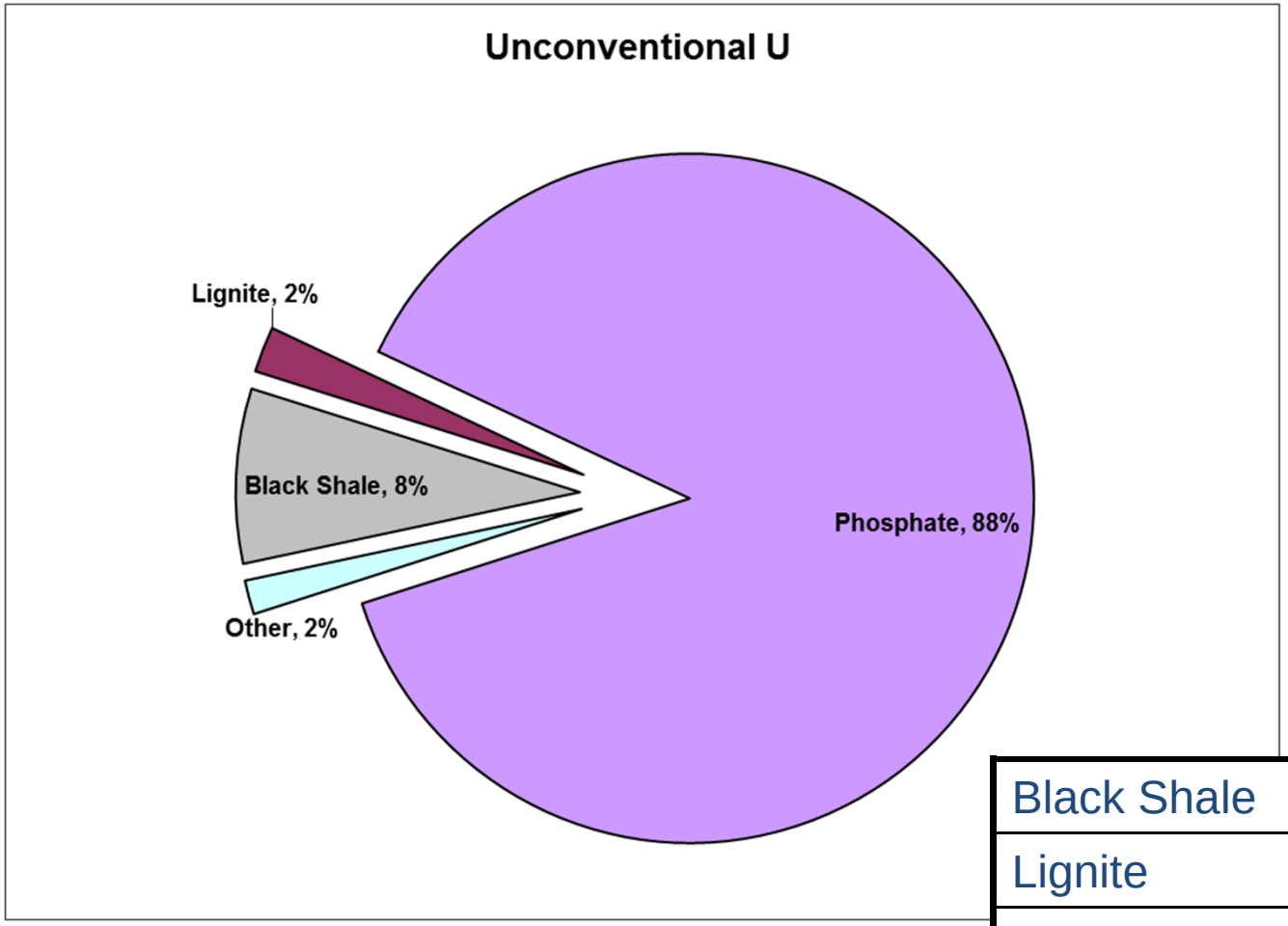
- The term “comprehensive extraction” was (re)introduced by Dr. Pingru Zhong (China) during an IAEA UxP Technical Meeting, September 26-30, 2011
- Roots in Russian and Chinese research, 1990s (R. Villas-Bôas)
- Disturb the ground once… extract everything of value in one pass
- Brought into currency during the follow-on Training Workshop, Marrakech, October 31 – November 5, 2011
- Focus on unconventional U resources, mainly Phosphates
- Rethink the flowsheet… rethink the outcome
- Already happening

See http://www.iaea.org/OurWork/ST/NE/NEFW/News/2011/repository/New-Comprehensive-Approaches-to-Uranium-Mining-and-Extraction.html

Example: Uranium supply reference case



Unconventional (Green?) U Resources

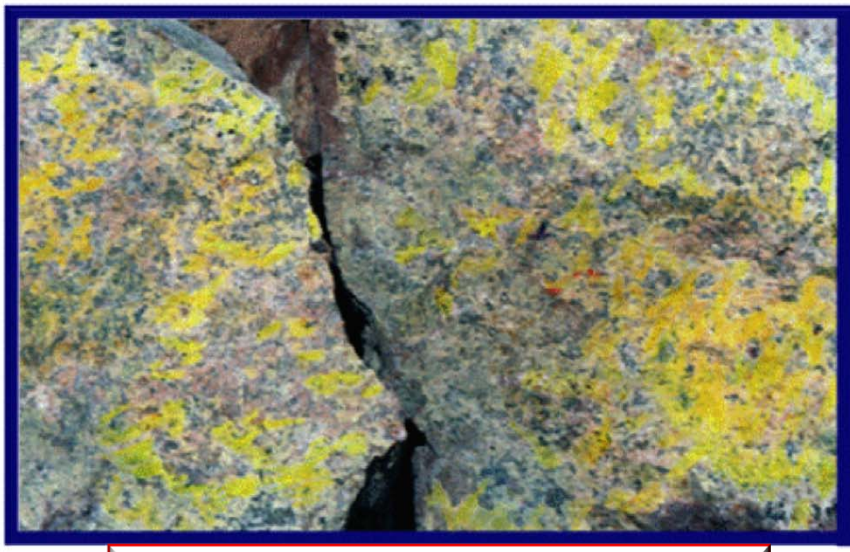


UDEPO, 2012

Black Shale	1,199,086
Lignite	313,685
Phosphates	12,894,830
Other	234,137
Total	**14,641,738**

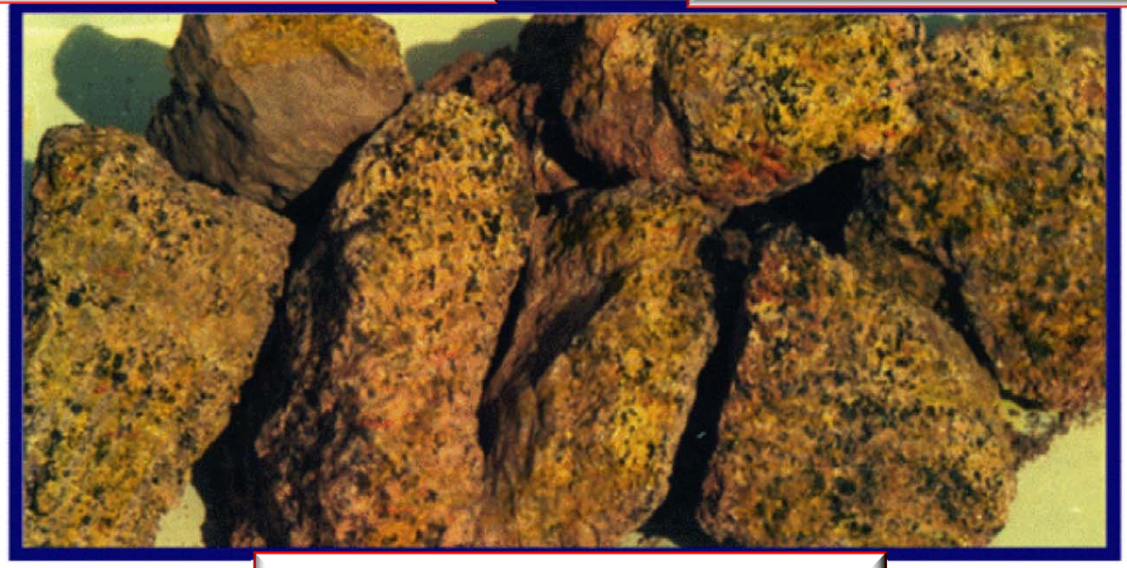
Define the new equilibrium: what do we mean by U “mining”?

“Solid” mining?



Uranium mineral (yellow) in Granite

Uranium mineral (yellow) in El-Hammat



Uranium mineral (yellow) in Granite

NMA, Egypt

“Liquid” mining?

Yellowcake – from both

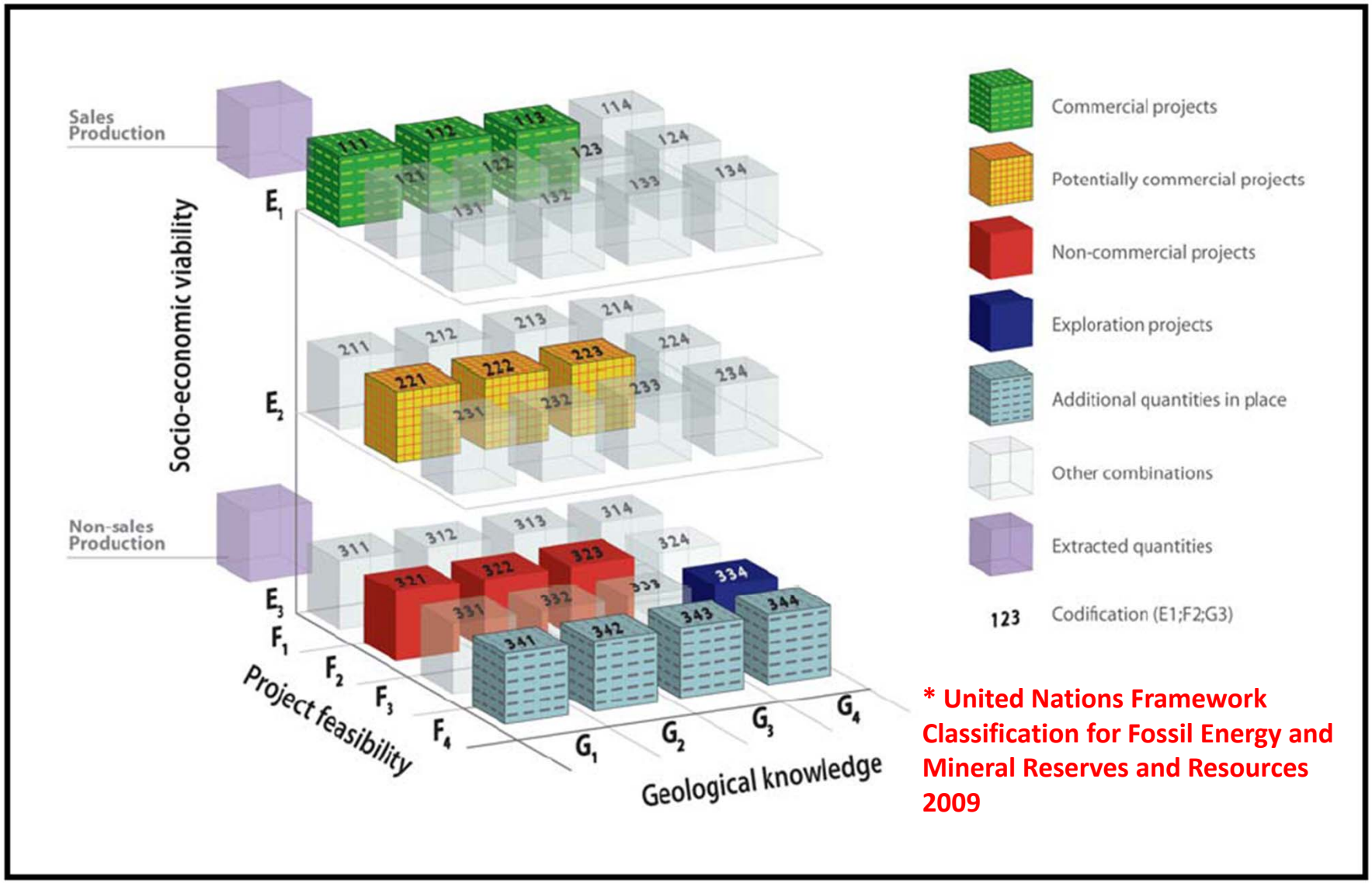
Yellowcake

- Product of the uranium extraction (milling) process.
- A mixture of uranium oxides that can vary in proportion and in colour from yellow to orange to dark green (blackish) depending at which temperature the material was dried or calcined (level of hydration and impurities).
  - Higher drying temperatures produce a darker, less soluble material.
- As a product, commonly referred to as U_3O_8. A fine powder packaged in drums and shipped to a conversion plant producing uranium hexafluoride (UF_6) - next step in nuclear fuel manufacture.

2. Mapping the New Point of Equilibrium: UNFC

There is a very compelling case for solving the problems UNFC is trying to fix. It is necessary, but is the tool yet sufficient?

UNFC 2009* Resource Classification



*** United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009**

Triple Bottom Line Mapped to UNFC (Scorecard approach)

- Available (environmental)
- Affordable (economic)
- Useful (social)

- **G**eology (Classification, Quantification, Accessibility)
- **E**conomics (Cost as Financial, Social, Environmental)
- **F**ruitfulness (Return as Financial, Social, Environmental)

Problems (that need fixing?)

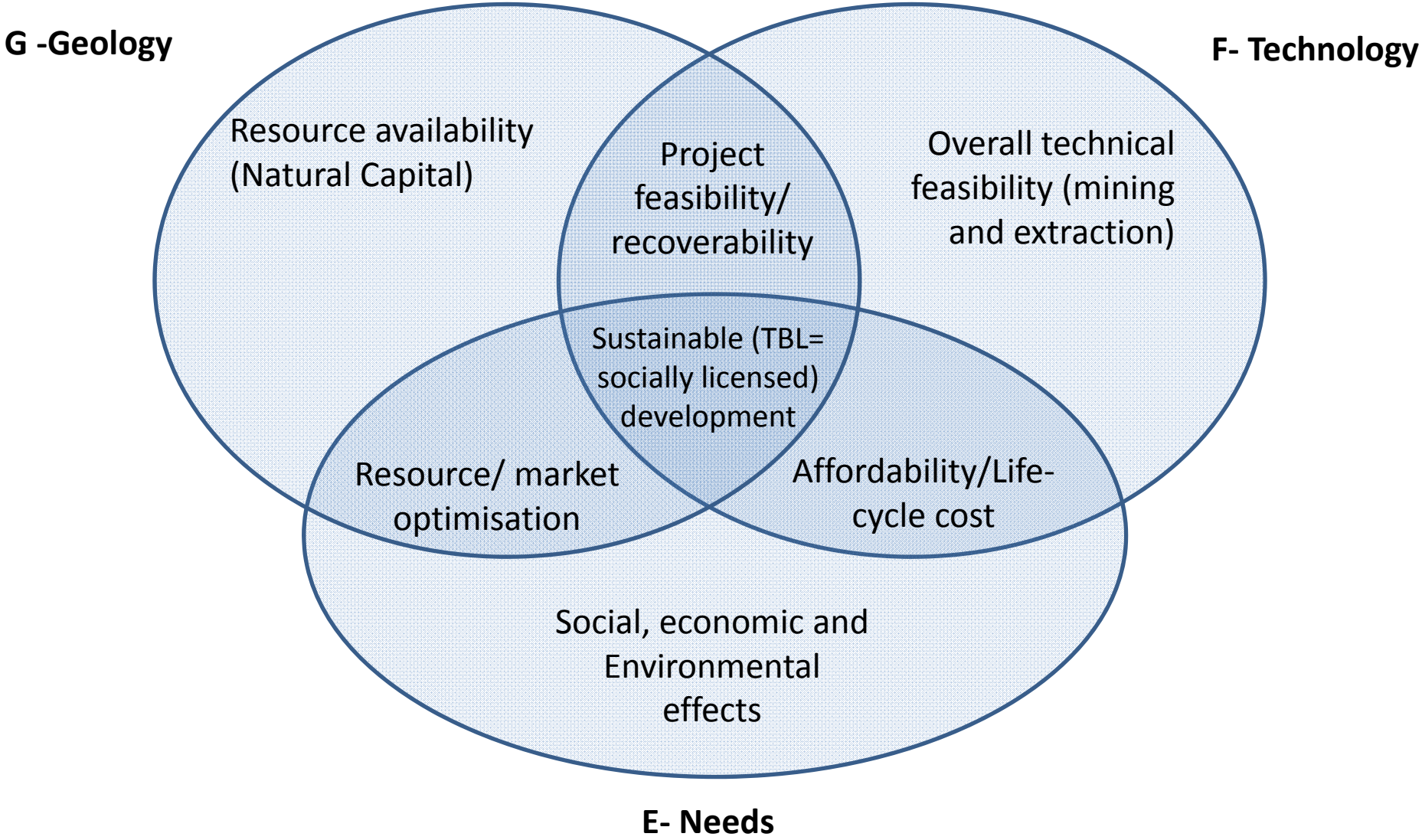
The tool – currently a score-card rather than a taxonomy

- **Taxonomy:** taxonomically, F is a sub-set of E, not a superordinate construct
  - The taxonomy needs to be changed to be inherently robust
  - Definitions (eg resources and reserves) need to derive from the taxonomy, not vice versa
  - Outcomes need to be consistent
- **Policy:** in terms of sustainability and resource conservation (life-cycle management), there is no direct "map" to UNFC
  - This could be fixed by extending the taxonomy across the life-cycle
- **Benefit:** to demonstrate real benefit it must fix the "Soros" problem – Structural imbalance between global markets and local standards and regulations

Two taxonomic options

- Extrinsic (needs-driven (“pull”) = score card)
  - (E) Economic Needs – why are we doing this?
  - (F) (Project) Mining and Extraction Technology – how, and at what cost ?
  - (G) Geology – What resources do we have and how much of each?
- Intrinsic (science-driven “push” = algorithm)
  - Feasibility (derives from G and F)
  - Resource Optimisation (derives from E and F)
  - Social Licensing (derives from G and E)

Fixing the Taxonomy



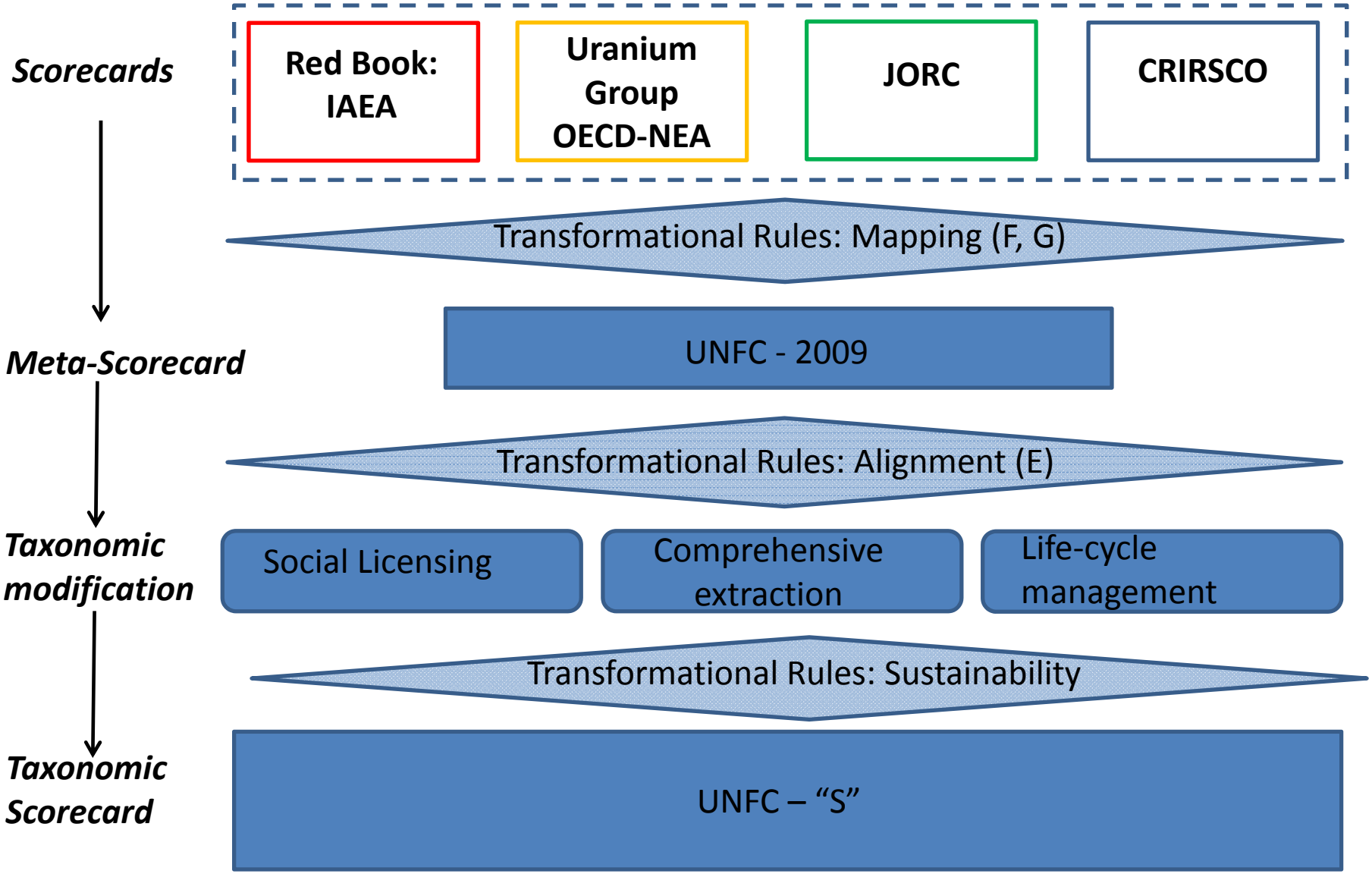
Pathway to UNFC “S” (future Sustainability edition)

Necessary and sufficient conditions for success

Three Steps to UNFC – “S”

1. Convergence: U → UNFC 2009 Convergence Process
2. Transformation: UNFC 2009 – Taxonomic Transformation:
    1. F Axis becomes “Framework”, and
    2. “Project” becomes “Sustainable Development Programme
3. Sustainability – UNFC “S” based on Sustainable Development Programmes

U → UNFC → UNFC "S" Pathway (?)



3. Comprehensive Extraction: The Implementation Road Map

Operationalising sustainable development – **necessary** conditions

- Accurate and transparent management of essential resources and reserves (Natural capital/ geological endowment, EGRC-3/2012/INF.1 N.34)
  - Managing natural capital not new concept: see Darwin's "bank" (**Origin of Species**)
- Closed (renewable) systems where possible
  - Recycling and reuse
  - Efficient use of inputs
  - Optimisation (and use) of all outputs
  - Waste elimination/ waste as designation of last resource

Operationalising sustainable development – **sufficient** conditions

- Transparent, accountable governance
- Stakeholder engagement / risk communications
- Coherent and consistent global regulations
- Equitable balance between interests of stakeholders and stockholders

= return on shared asset, not just return on private investment

Not just about getting stuff out of the ground, we want to change the point of equilibrium: close the system

Comprehensive Extraction: Extract all minerals, not just the commodity target - example P, U and REE

Prevent Loss and Leakage

Recover and Reuse

Why? - Policy, Practice and Profit

- **Policy:** Fill gaps in supply (security; national self-sufficiency)
- **Practice:** Explore and exploit "lower impact" / "green" U sources (little or no additional mining; low energy and water needs)
- **Profit:** Turn "wastes" to "resources" (wealth) (eg PG) and eliminate negative externality
- Seek other similar "cooperative" (Nash – "win/win") solutions to increase stakeholder acceptance/ reduce stakeholder anxiety
- Focus on life-cycle management
- *Reference example U from P fertilisers:*
  - *remove "contaminant" content from Phosphates/ P fertilisers*
  - *turn "contaminants" into resources U, REE, Th, Mg, F etc*

U x P

- Available in P acid
- Affordable – known quantities, technology and cost
- Useful – nuclear fuel, reduced total environmental impact for U extraction/ recovery, contaminant removed from soil

So why are we throwing it away? (along with REE, Th…)

Estimates of P Losses in P Lifecycle … (5-15% efficient)

Mining	• 100% if P_2O_5 content is below 28.5% (China) • Higher BPL largely mined; Lower BPL values now in play • Shifting boundary between reserve and resource
Mining and Beneficiation	• Range: 20-30% (eg Florida) – loss focused on clay
Chemical Processing	• Up to 2.5% - undigested rock going to phosphogypsum • Some acid goes to the stack (wet process) • Industry claim is 98%+ total recovery • U, REE, Th etc all lost to fertiliser or phosphogypsum
Agriculture/ Food Production (incl fish)	• Erosion • Poor practices, including inappropriate fertilisation, poor choice of crop, • Need to follow Critical P model
Houshold Waste	• Estimates as high as 70% of fruit and vegetable produce bought in eg UK goes straight to landfill (WRAP Study, 2009) • Sewage/ Wastewater processing – option to recover ~ all P
Waste Streams	• Animal manure • Slaughter (bones and carcasses) • Industry – wide range of products incl detergents, fire retardants etc

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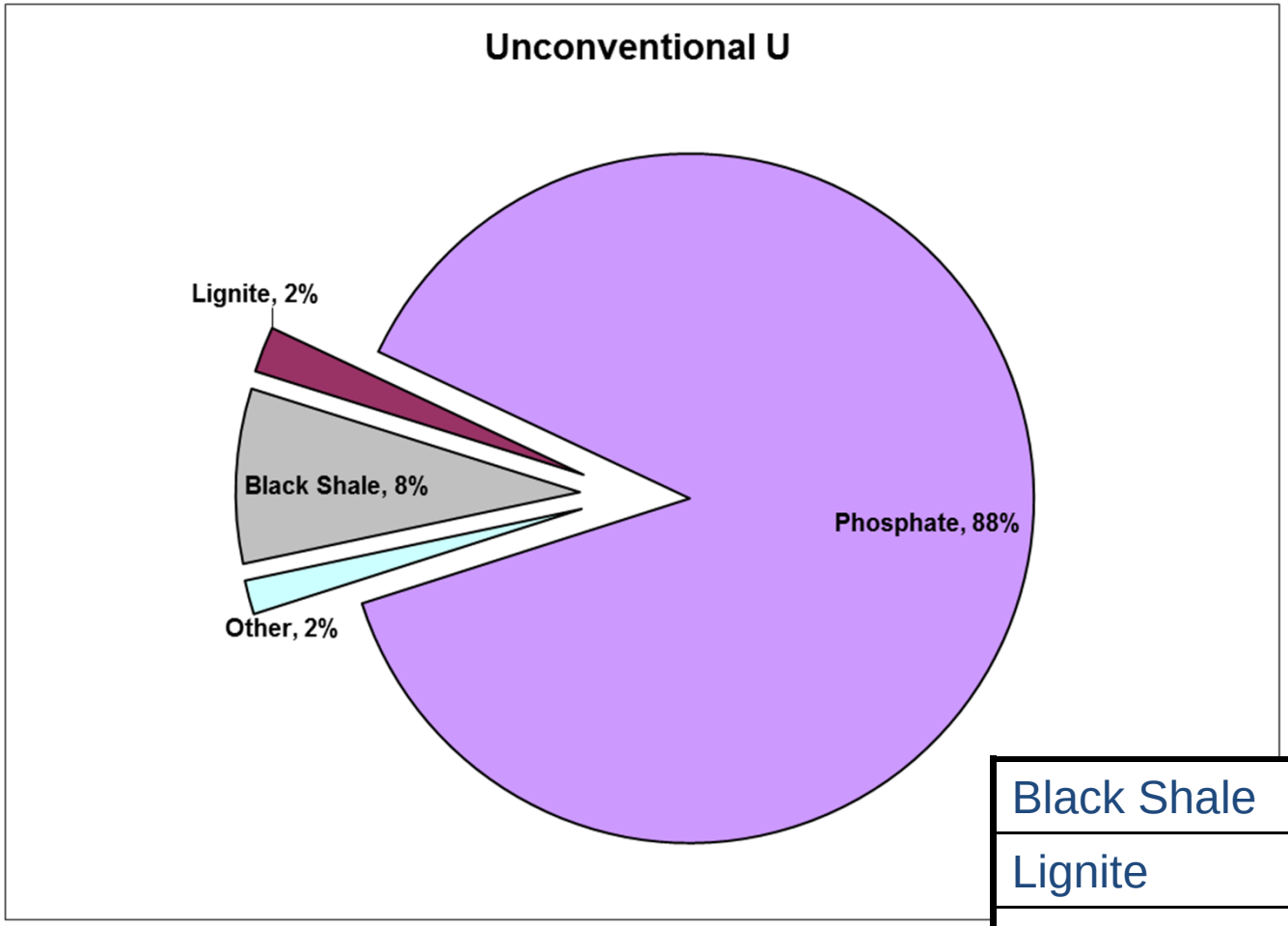

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The “Ux” Expert Working Group

ToR April 20, 2012

An Expert Working Group shall be established to address all aspects of safe and sustainable extraction of U, Th, REE, and other elements of interest, from resources such as phosphates, monazite and ores of base metals containing these elements.

Its Terms of Reference include but are not restricted to:

Expert Working Group ToR

(as of September 2012)

Assisting MS in adopting

- technologies and good practices for safe, sustainable mining, processing and peaceful/ civil uses, of U, Th, and REE
- wider systemic measures in the mineral processing industries for optimising
  - resource conservation
  - product life-cycle management at critical points such as
    - environmental effects
    - residue management, use and/or disposal
    - decommissioning

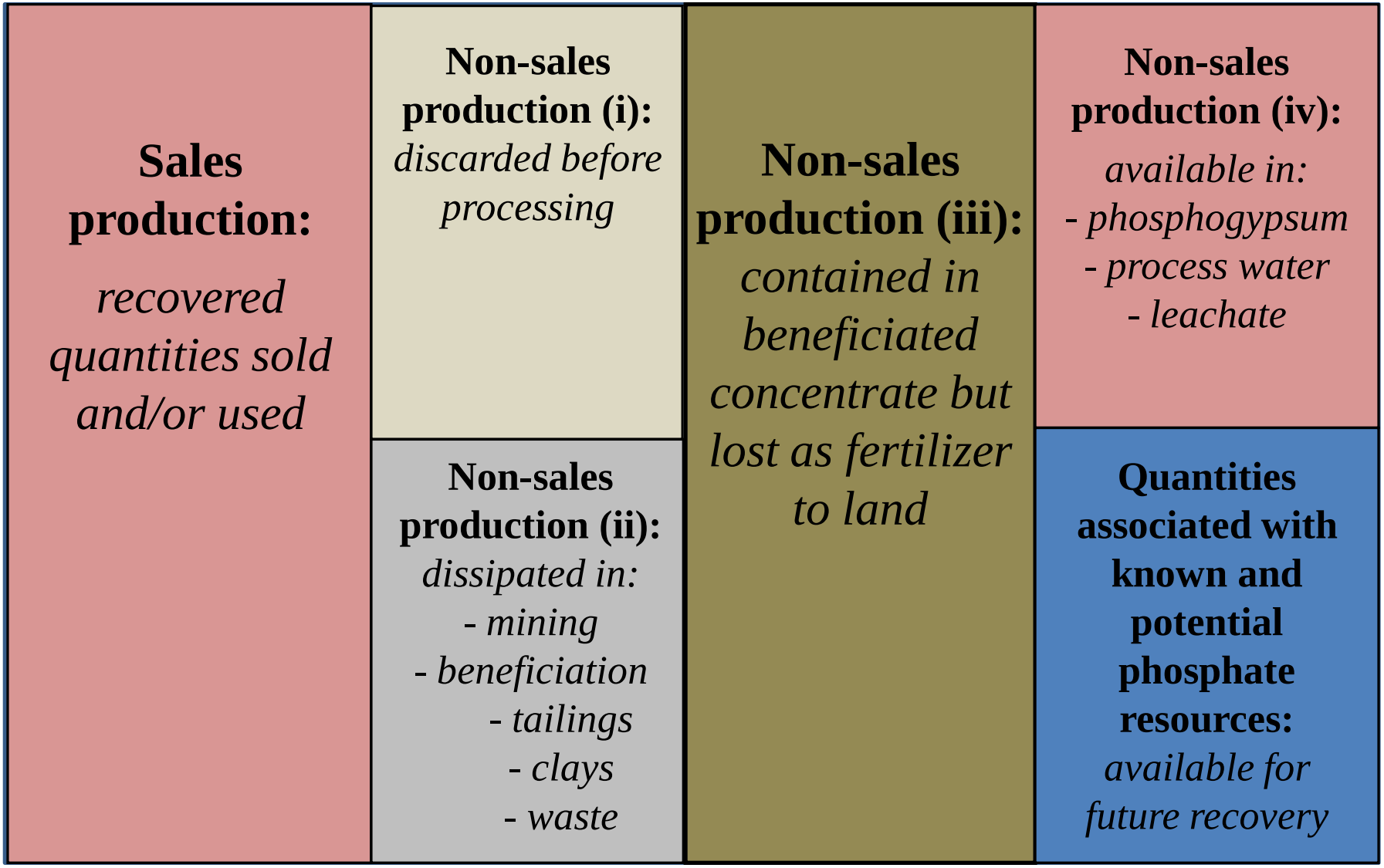
Methodology: Using the United Nations Framework Classification

Using the first three of the United Nations Framework Classification (UNFC) [1] categories as a basis for the nomenclature, there are six broad categories of uranium allocation for extraction from phosphate resources (see Figure 1):

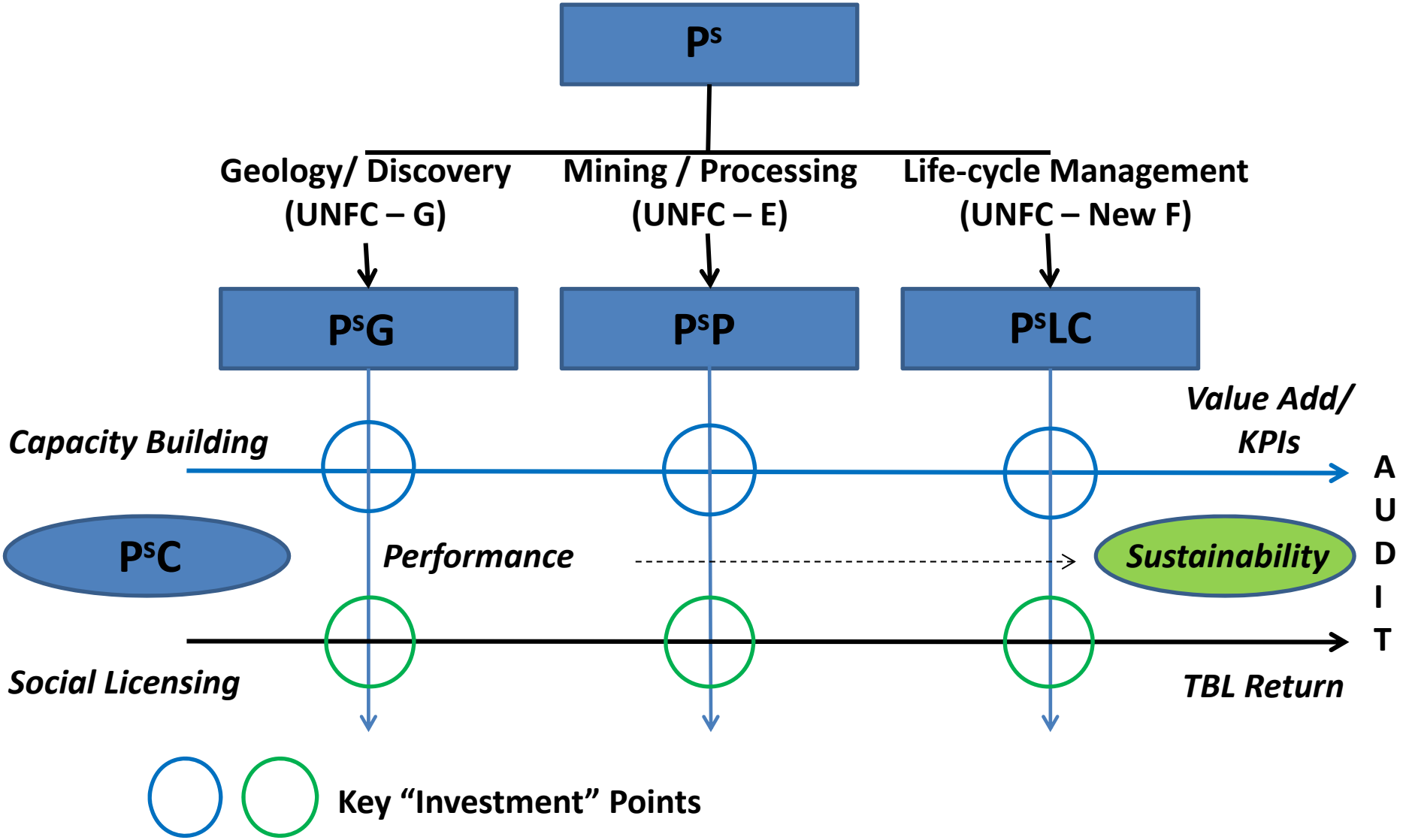
1. Extracted quantities from Waves 1 and 2 including known US sales production (Figure 2)
2. Non-sales production discarded before processing or wasted
3. Non-sales production lost during mining and beneficiation
4. Non-sales production contained in fertilizer product and lost to land
5. Non-sales production available from sale production in process water, phosphogypsum and leachate
6. Quantities associated with known and potential deposits available for future recovery

[1] UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE, United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009, ECE Energy Series No.39, Geneva and New York (2009).

Uranium “pools” in phosphate resources, mapped to UNFC

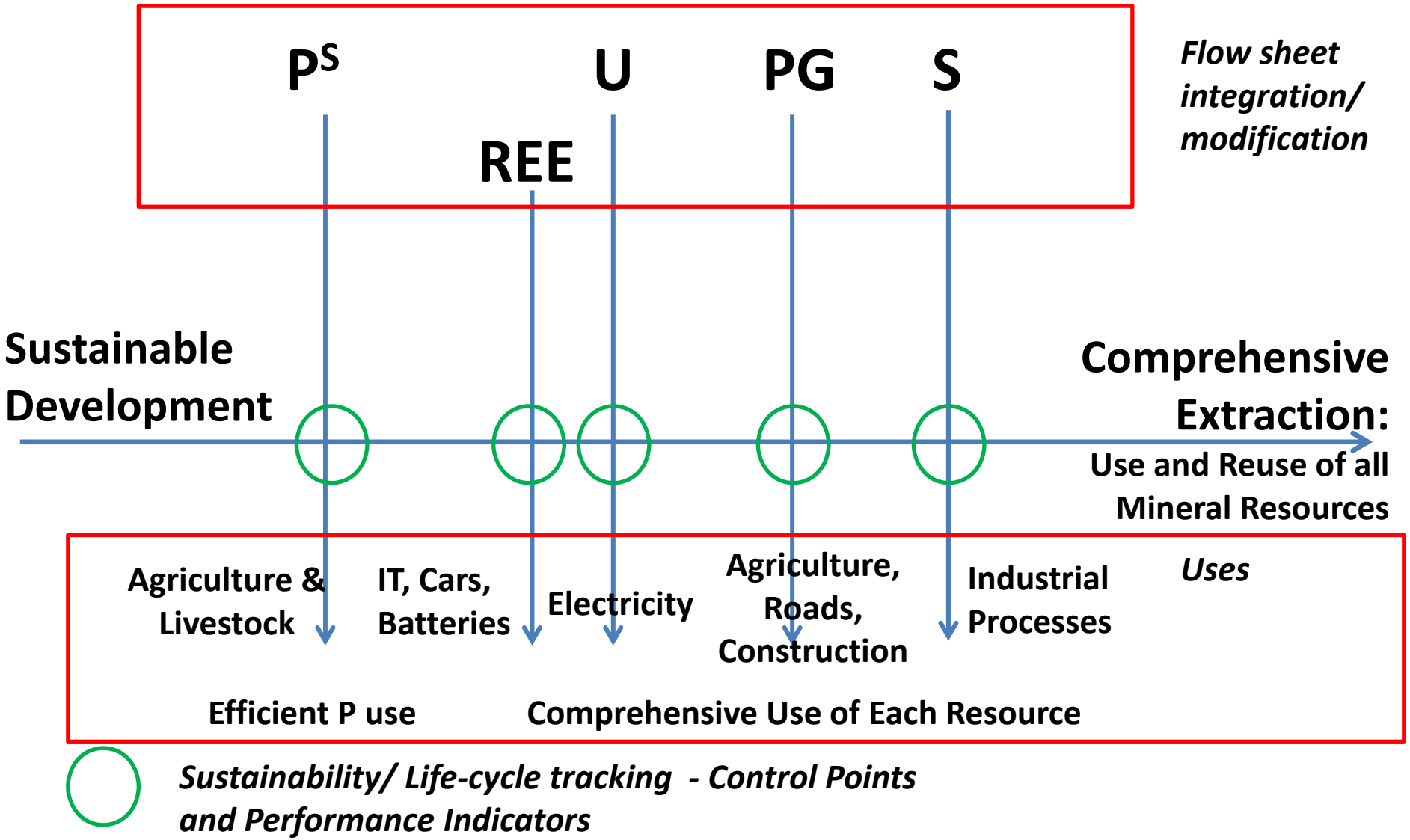


Connecting the Expert Working Group to P^S Lifecycle Structure and Operation



Outcome: sustainable uses of P ores (P^S)

Means: integrated flow sheet/ control points/ performance indicators



UxP: Snapshot

Countries at varying stages of engagement, or with varying technology solutions (operations and/or feasibility) include:

- Algeria, Australia, Belgium, Brazil, Canada, China, Egypt, India, Iraq, Jordan, Morocco, Philippines, Saudi Arabia, Spain, South Africa, Tanzania, Tunisia, Turkey, USA

Many more are considering this approach.

Tasks for this week

- Evaluate opportunities for each MS (you) to adopt a “comprehensive extraction” approach in Triple Bottom Line terms (economic, social and environmental)
- Put that in context with UNFC (2009)
- Align with sustainable development objectives (UNFC “S”)
- Define your needs under INT/2/015 and what support you would like from IAEA/ EWG, and REPORT ON THURSDAY 11.30-12.30 FOR THE MEETING REPORT eg:
  1. Strategic/ policy options
  2. Technical assistance (technology selection, transfer and performance)
  3. Capacity building/ building and supporting the Ux professional network
  4. Policy development
  5. Regulatory requirements, including safety, security, safeguards
  6. Social licensing

Obrigado… Gracias

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