Theory to Practice:
The Scope, Purpose and Practice of Prefeasibility Studies for Critical Resources in the Era of Sustainable Development

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Julian Hilton

Chairman, Aleff Group

Chair IAEA/OECD-NEA UxP

Expert Working Group

U 4G

The PFS Menu

1. Context
2. Scope
3. Purpose
4. Practice

1. Context

Sustainable development

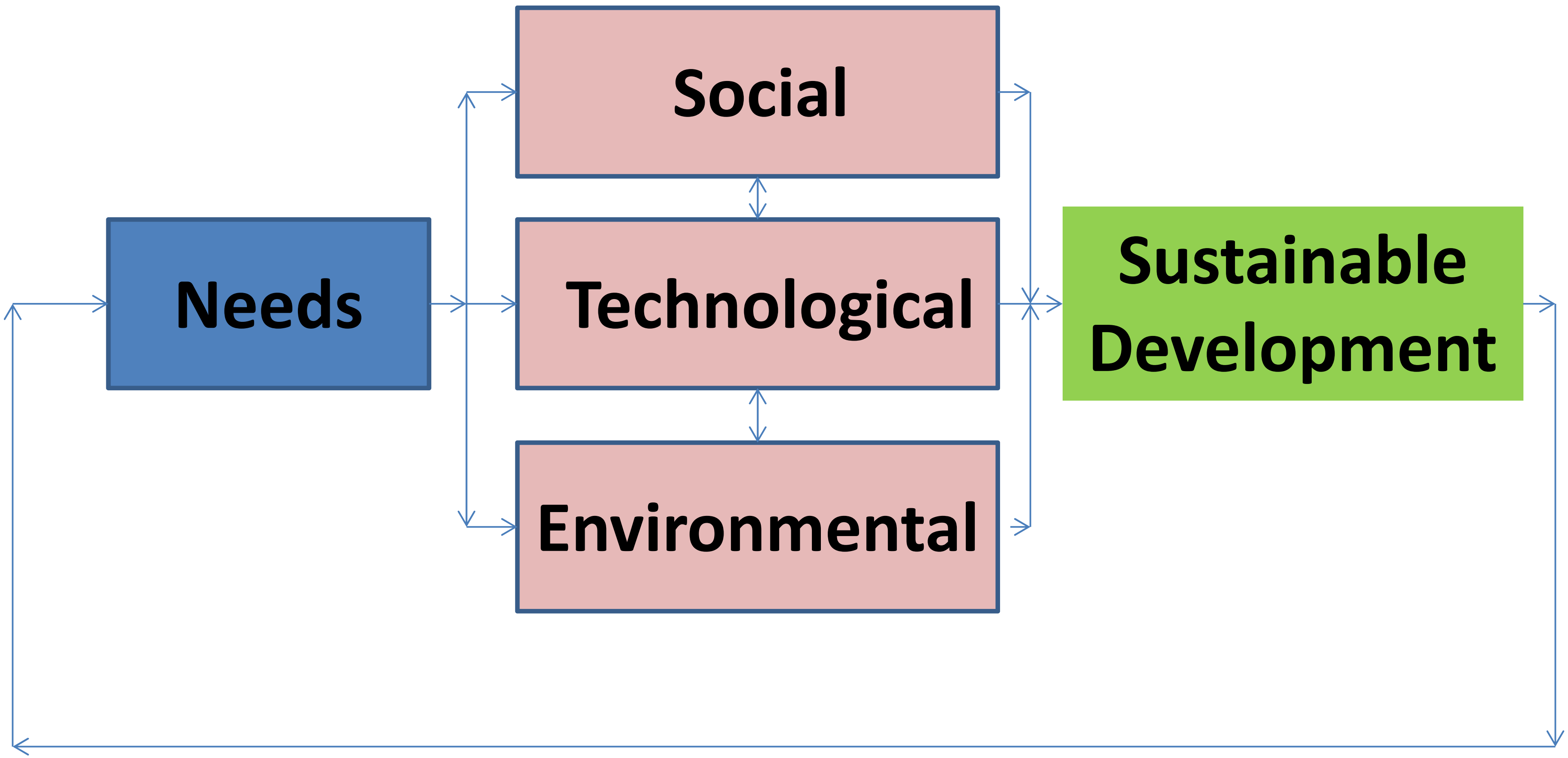
THE SUSTAINABLE DEVELOPMENT CYCLE

Introduced by Gro Harlem Brundtland[1], (UNWCED), Our Common Future, Oxford: Oxford University Press, (1987)

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- *the concept of **needs**, in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *the idea of **limitations** imposed by the state of technology and social organization on the environment's ability to meet present and future needs."*

The Cycle of Needs and Limitations



Triple Bottom Line (TBL)

- Introduced by John Elkington, 1994 in California Business Review[1]
- Direct response to the Brundtland/ Sustainability agenda – becomes an enterprise obligation
- Three variables must all apply to enterprise or organisational performance:
  - Economic/ financial
  - Social
  - Environmental
- Derived from John Nash's Nobel prize-winning cooperative game theory – the win/win [2]

1: ELKINGTON, J., "Towards the sustainable corporation: Win-win-win business strategies for sustainable development", California Management Review 36, **2**, 90-100, (1994).

2. NASH, J., Non-cooperative Games, *Annals of Mathematics*, **54**, 286-295, (1950).

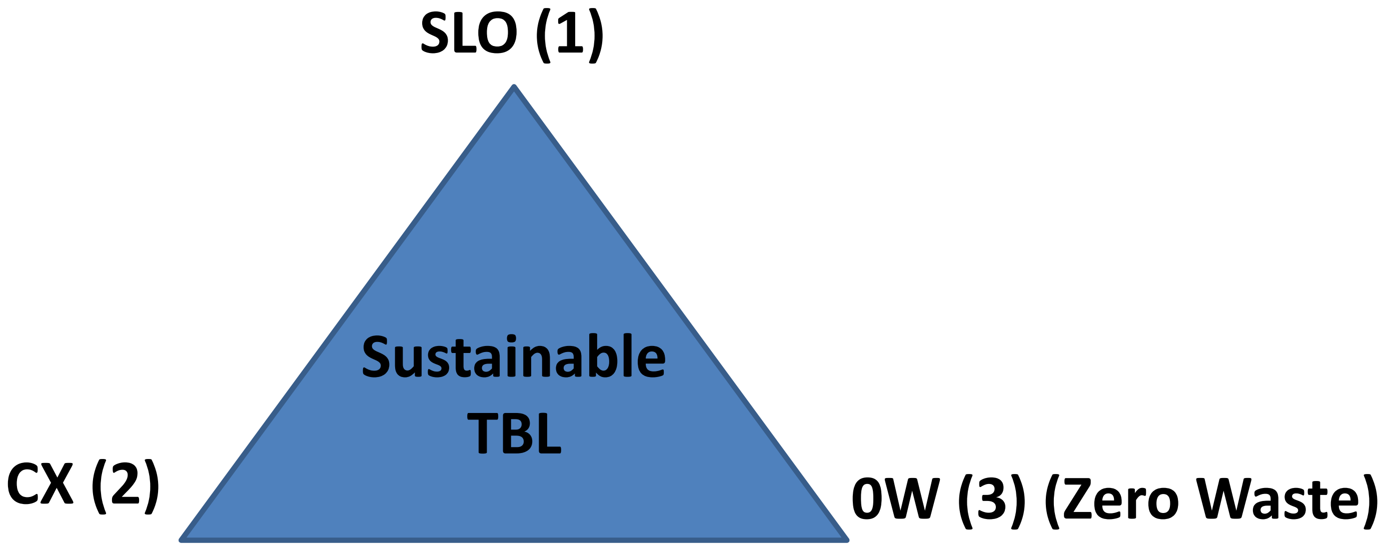
2. Scope

Aligning core “TBL” Principles with Sustainability

Raising the IAEA Dividend

Scope:

- TBL 1 - Social licence to operate (SLO) (**social**)
- TBL 2 - Comprehensive extraction (CX) (**techno-economic**)
- TBL 3 - Zero waste (0W) (**environmental**)



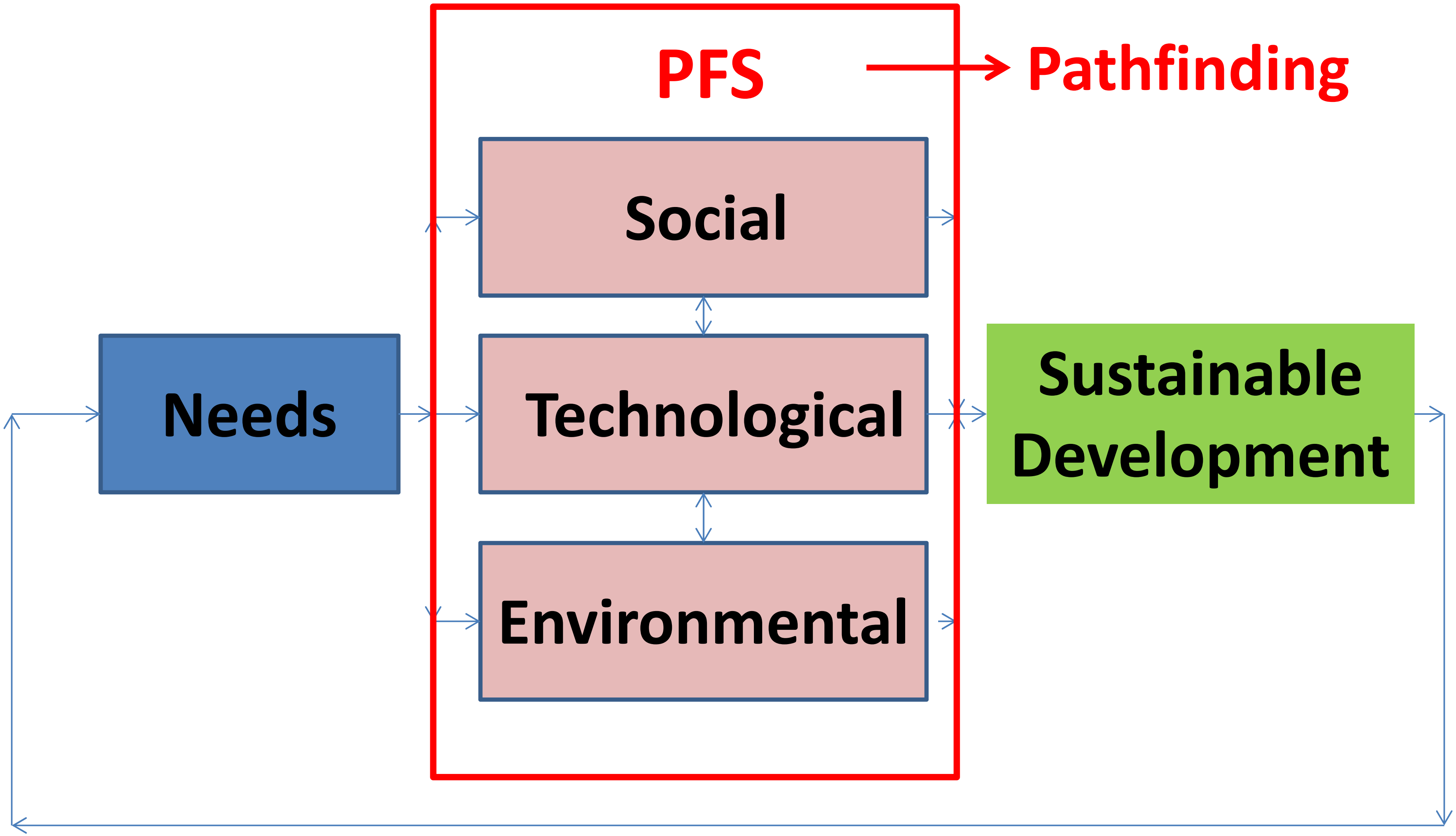
Safety and Sustainability

- A strong mutual dependency has been identified between the objectives of HSE and sustainable development goals, such as the sustainable management and use of critical mineral resources.
- A practice cannot be described as sustainable that is not also safe.

3. Purpose

An equitable, realistic, sustainable equilibrium of benefits for stockholders and stakeholders

The Cycle of Needs and Limitations



Pathways

= new business models

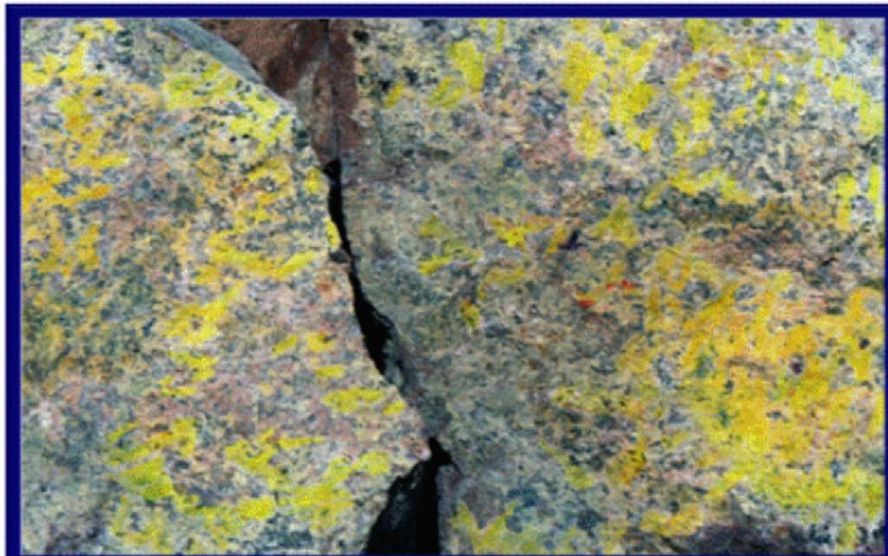
= new, compelling resource narratives…

= Future-proofing critical resources …

= Waste as definition of last resort…

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


Waste or Resource?
EoL or Futureproofing?

Learning New Competencies: Future-proofing the national mines

http://www.uxponline.com/resources/file/pdf/meet/uxp2013/UXP_NewsletterLisbonUraniumMineRemediationMarch2013.pdf

http://www.iaea.org/OurWork/ST/NE/NEFW/News/2012/repository/2012-11-09-Uranium-Meeting-Lisbon.html

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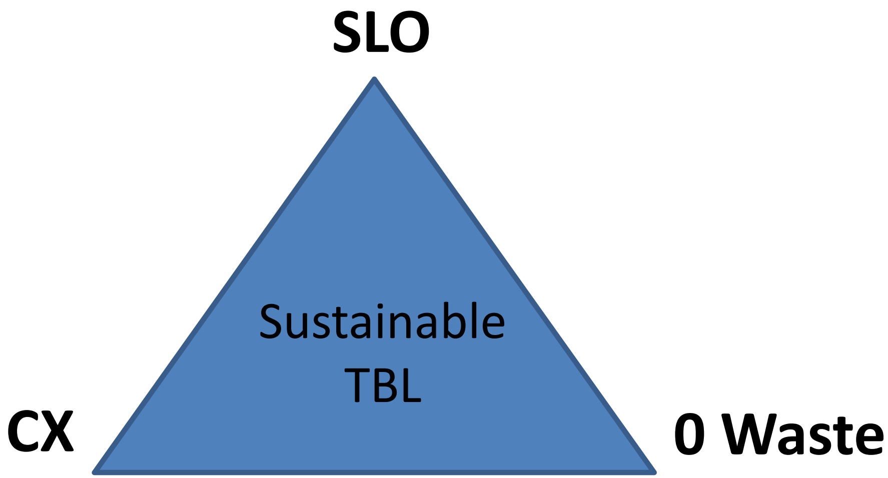
Core PFS "TBL" Objectives - New Business Models



The PFS

- De-risked financials/ ROI (protects lender/ investor)
- Stable, equitable, long-term partnerships with stakeholders
- Reduced risk of project-related social conflicts/ conflict-free supply chain/ compliance with EITI objectives
- Positive contribution to / reduced impact on health, culture and heritage
- Equitable balance of economic and environmental interest, eg new, NORM industry specific regulation (U, P, oil and gas, REE etc)

DRAFT: IAEA UxP Pre-Feasibility Study - Table of Contents

8.10 Process controls…………………………………………………………………..
8.11 Maintenance and upkeep
8.12 End of Life (EOL) Plan

9. Market Analysis……………………………………………………………..…………………..
9.1 Supply Analysis (including key assumptions)
9.1.1 Domestic
9.1.2 International
9.2 Demand Analysis (including key assumptions)
9.2.2 Domestic
- Volume
- Price
9.2.2 International
- Volume
- Price
9.3 Competitors/ Market Resilience
9.4 Market Risks……………………………………………..…………..
9.5 Supply chain / raw materials and other inputs……………………………………..…….
9.6 Transport and distribution
9.7 Taxes

10. Financial Assessment and Investment Requirements
10.1 Analysis of Financial Standing of Project Initiator, its Capacity to Implement Project including Strategic [Business] Plan….
10.2 Capital Costs (CAPEX) (Mapped to Length of Expected Loan/ Investment)
10.2.1 Reasonable/ Realistic Case
10.2.2 Pessimistic C

ase

10.3 Operating Costs (OPEX) (Mapped to Length of Expected Loan/ Investment)
10.3.1 Reasonable/ Realistic Case
10.3.2 Pessimistic Case
10.4 Working Capital and Cash Flow
10.5 Internal Rate of Return/ Return on Investment
10.6 Permits and Licences
10.7 Off-take agreements, Contracts,
10.8 Bonds and Special Provisions
10.9 Life-cycle Analysis

11. Costs of Construction including Timelines/ Drawdown Requirements/ Contingencies

12. Cross-cutting Issues and Requirements

13. Regulatory and Licensing Requirements

14. Project Risks…………………………………………………………………………..
14.1. Operational and Technical ……………………………………………………………………………
14.2. Environmental……………………………………………………..………………….
14.3. Financial and Economic………………………………………………………………….
14.4 Social
14.5 Political and Regulatory

NORM-industry specific regulation

- Equitable balance of environmental, occupational and economic interests…
- Evidence-based
- Graded approach

4. Practice

Into the world of co- and by-product U

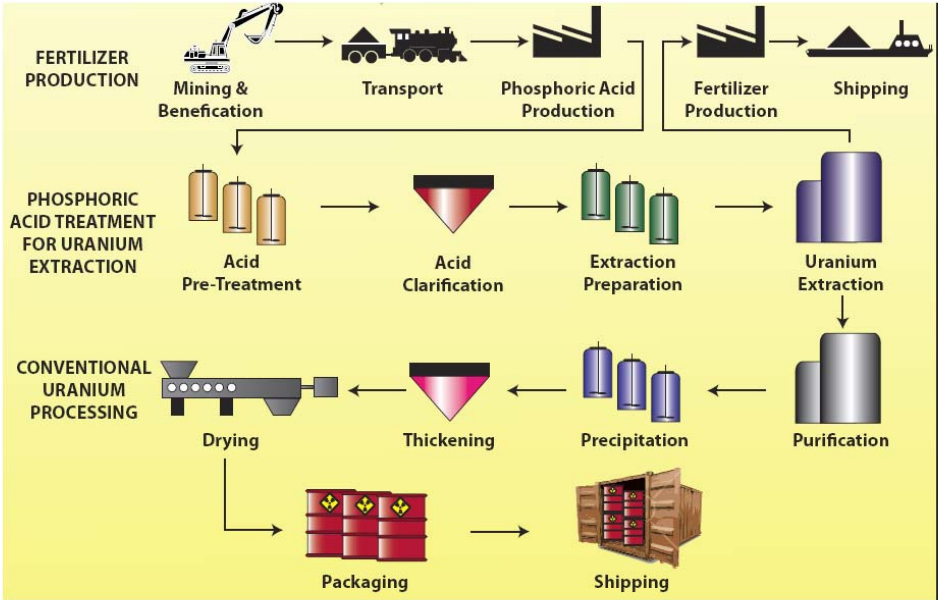
Have Your Yellowcake and Eat It?

What do I see?
Single Mineral or
Complex Resource? …
How conventional
do I feel?...

Comprehensive extraction

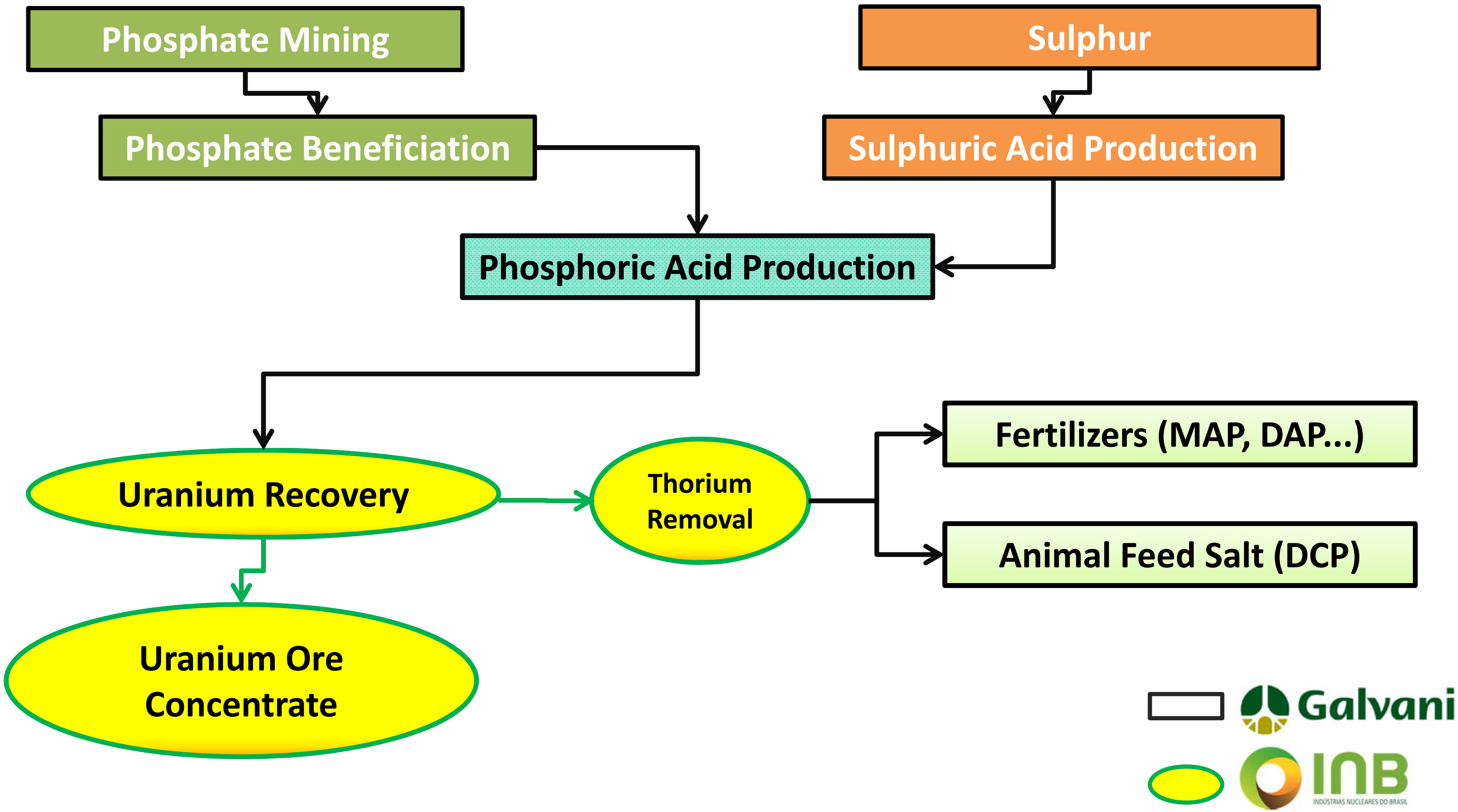
- Disturb the ground once: extract maximum benefits
- All the useful materials should be extracted from the ore
- Mine/ by-products "future proofed" (closed system, successive life-cycles)
- By-products and residues (re)used
- Waste streams minimised/ legacy costs greatly reduced

eg U, REE extraction from phosphates, base-metal ores etc



U, REE extraction from phosphates

Example: Santa Quiteria, Brazil, U and P Project Flowchart



Definitional Uncertainty – “conventional” and “unconventional” resources

- the distinction between conventional and unconventional is harder and harder to defend … As defined in the Red Book text attached conventional U may include sources of U as a by-product if the quantity is "important" or "significant“
- in the light of conventional mining activities often having very low grades (and hence are now being taken out of production) the distinction based on undefined "importance" does not really hold at either a quantitative level or a taxonomic level
- Reported at UNECE/ UNFC meeting April 2014 that the US SEC is now discouraging use of the distinction.

THE SUSTAINABLE DEVELOPMENT NARRATIVE

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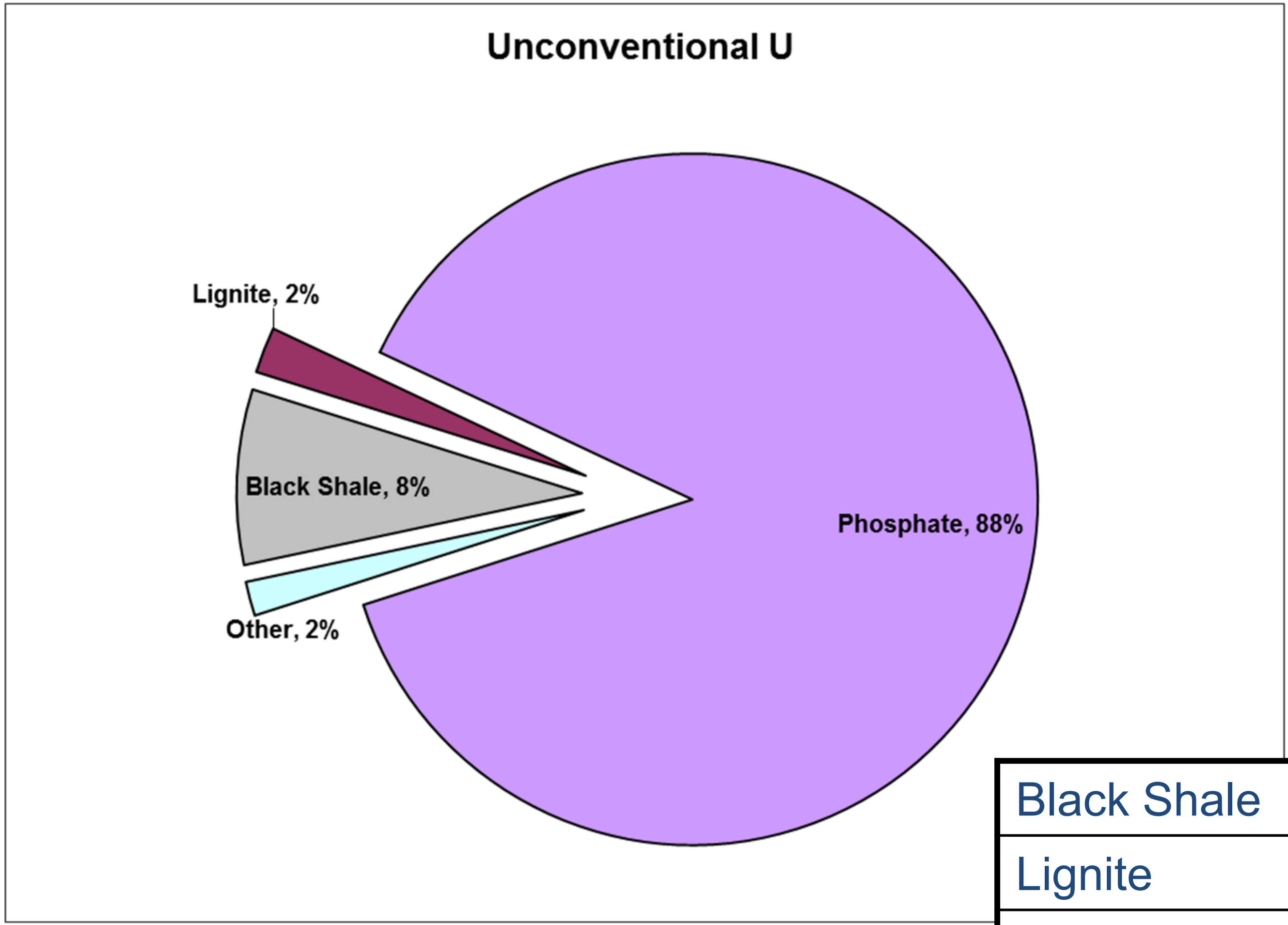
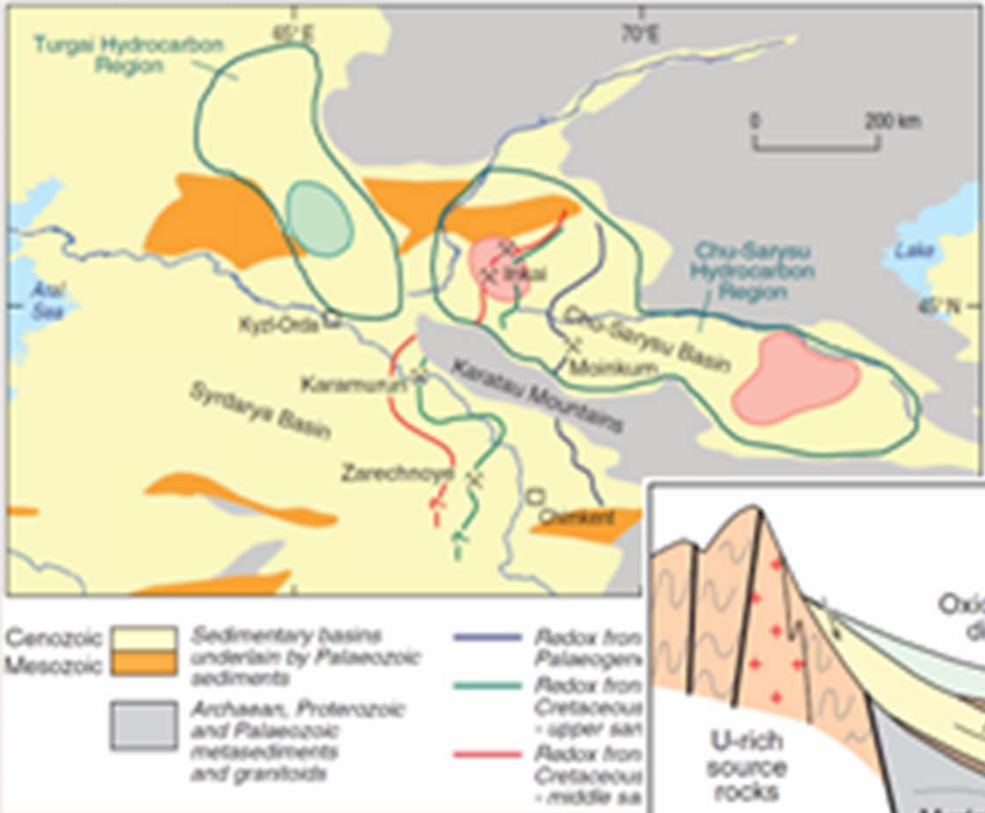


UDEPO, 2012

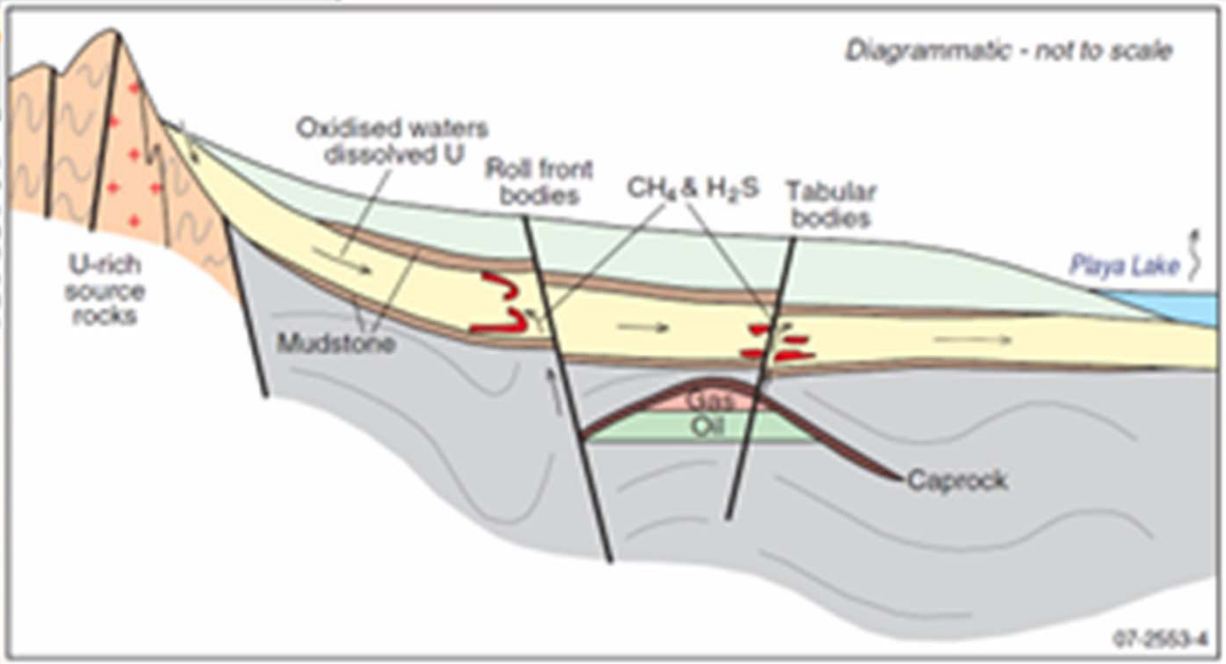
Black Shale	1,199,086
Lignite	313,685
Phosphates	12,894,830
Other	234,137
Total	**14,641,738**

Kazakhstan – energy basin with U and hydrocarbons

Slide, courtesy Hari Tulsidas, IAEA



- Possible link between oil & gas and uranium, with associated migration of gas along faults, tectonic control of the localisation of roll fronts...



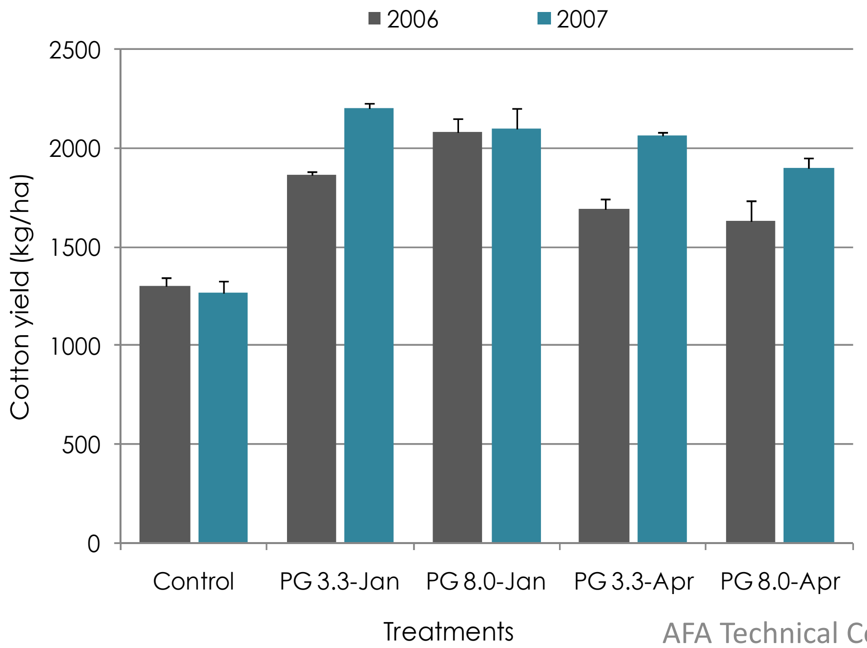
Jaireth et al. 2008

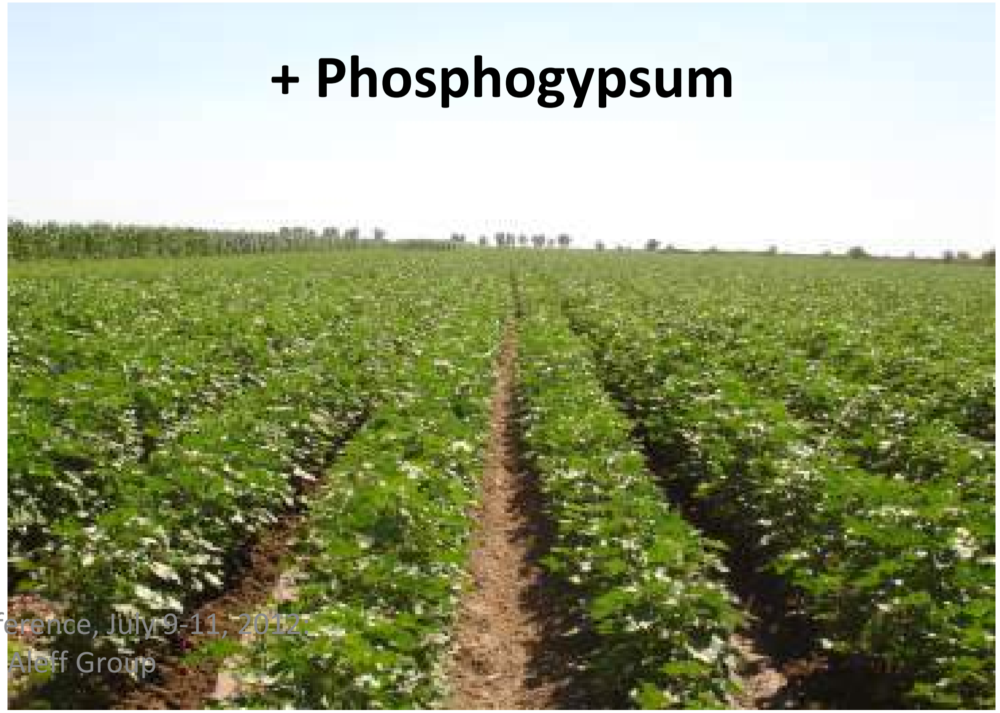
What do I mean by waste?


Lose it?

Kazakhstan

Cotton Growth and Yield (up to 200-300% increase over 3 years, (ICARDA))





Rationale – Rethinking "Waste"

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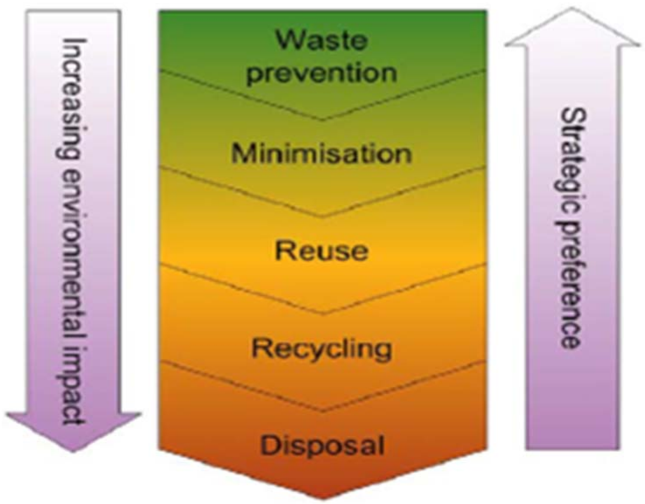
- Projects for managing any waste in isolation from the processes that generate them are running against the policy objectives of the waste hierarchy (e.g., EU Waste Framework Directive, 1975; US Non-Hazardous Waste Management Hierarchy)
  - disposal as the last, and least desirable of the management options
  - projects showing signs of **"not performing well when undertaken purely as waste management tasks"**

EU



US

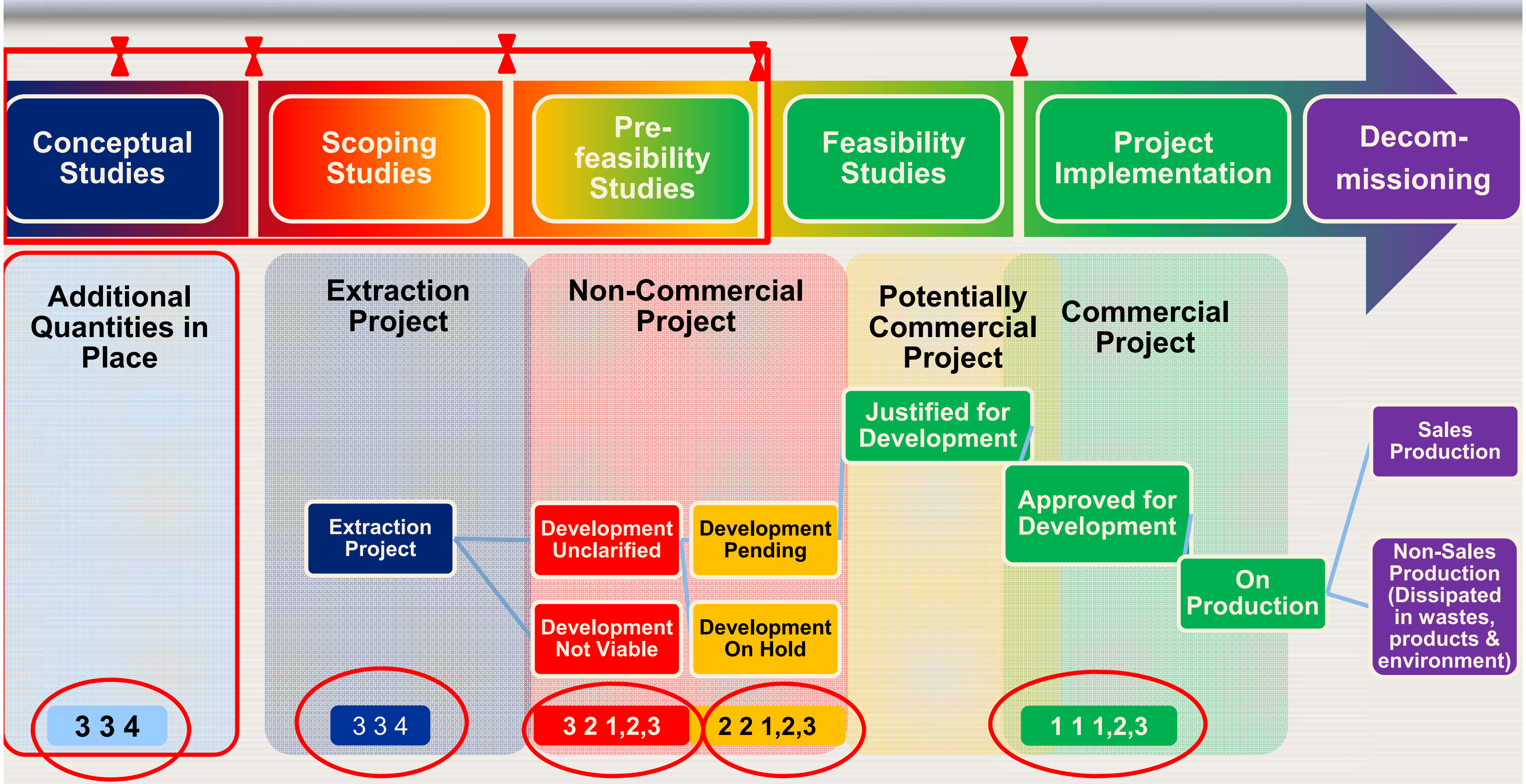
Waste Hierarchy

- progressive / step-wise transformation of waste to resource, with a hierarchy of waste itself premised as
  - i. prevention (or transformation to resource),
  - ii. minimisation,
  - iii. reuse;
  - iv, recycling,
  - v. disposal.

Resource data

- Reliability
- Transparency
- Currency
- Degree of criticality

Comprehensive extraction lifecycle



Accurate and transparent management of essential materials throughout the lifecycle

A New U?

- Uranium has lived in a world apart since its sudden promotion to prime asset in the military sphere. It has struggled since 1945 to tell its elemental story as a source of clean, reliable energy and has let itself down in the past with poor mining practices (Rum Jungle) and inept management of nuclear power facilities. It has often chosen isolation over engagement.
- But there is a new, much older story to tell, and that story is now coming out, led from the major emerging economies, the “BRICS” not from the developed world.
- URAM 2014 might just be looked back on as the day that page in uranium’s history was turned, turned by, or perhaps on behalf of, those to whom energy security, access and affordability is a compelling, life-defining need.

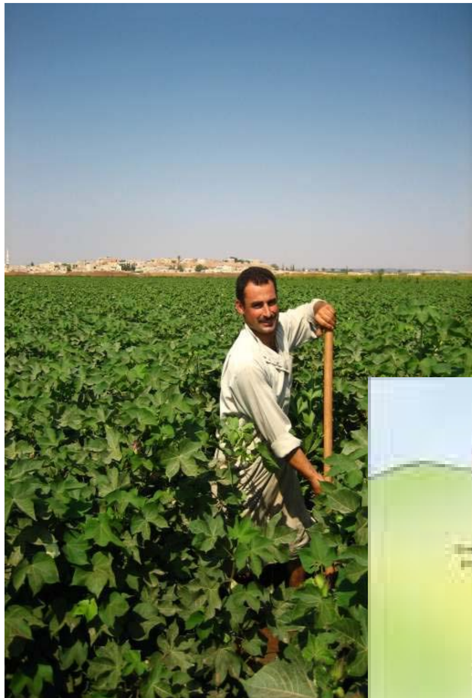
- Safety – a "social/ organizational" concept
- Sustainability – critically dependent on TBL "techno-economic feasibility" (how to do things affordably well)
- Resulting in assurance of "*the environment's ability to meet present and future needs*"

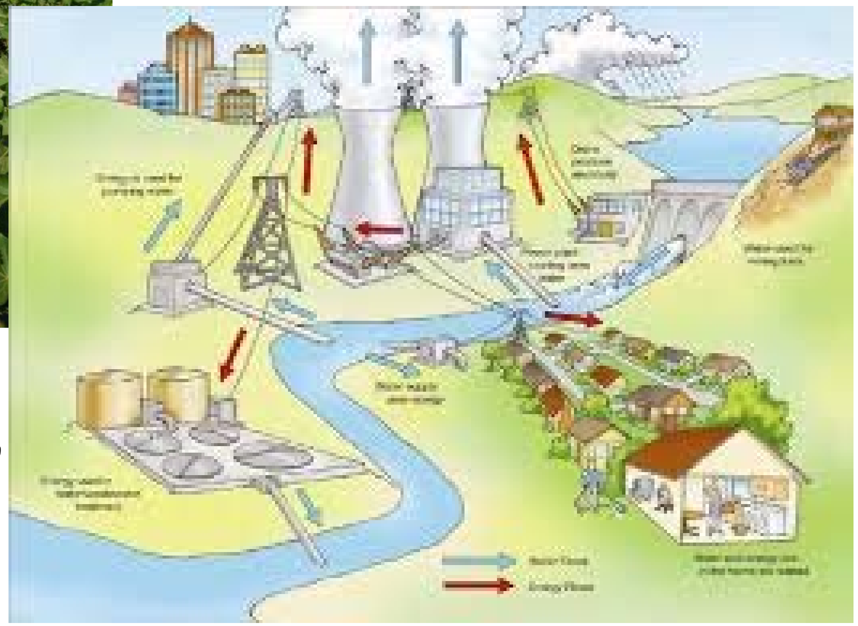
Outcome = "Social Licence"

= The New Sustainable Equilibrium between Stockholders and Stakeholders

SECURE THE "FEW"

- Food security
- Energy security
- Water security





"SUSTAIN THE MANY"

U 4G

Smart mine

Green U

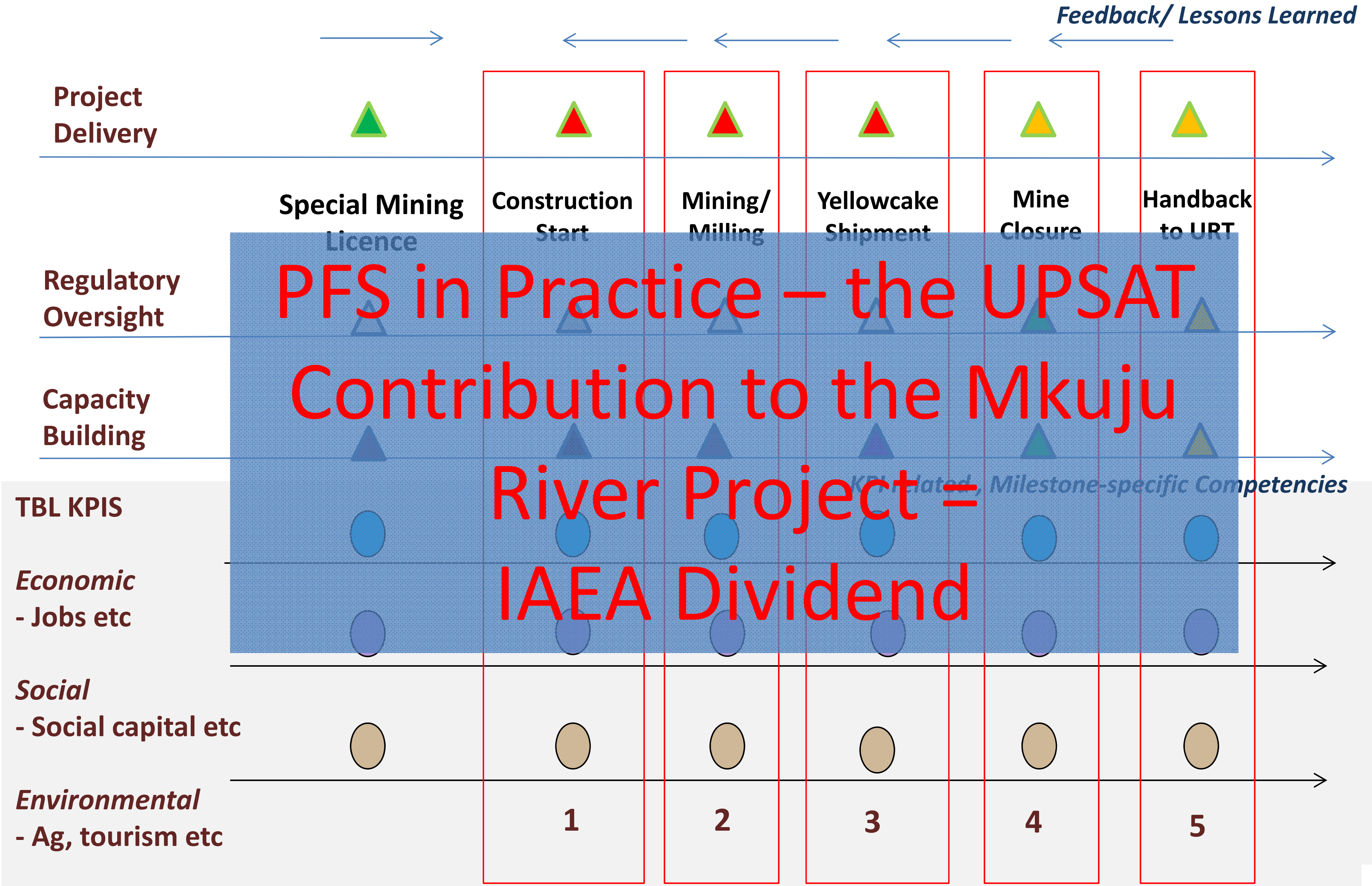
Fuel security

Clean, safe, affordable energy

Social capital

MRP DASHBOARD: MILESTONE-DRIVEN, INTEGRATED SOCIAL LICENCE AND CAPACITY-BUILDING

PFS in Practice – the UPSAT Contribution to the Mkuju River Project = IAEA Dividend



Map milestones and competencies into an activity matrix

Thank you!

jhilton@aleffgroup.com