SMI CSRM
Centre for Social Responsibility in Mining

Non-renewable but Sustainable: Confronting Environmental and Social Challenges to the Raw Materials Industry

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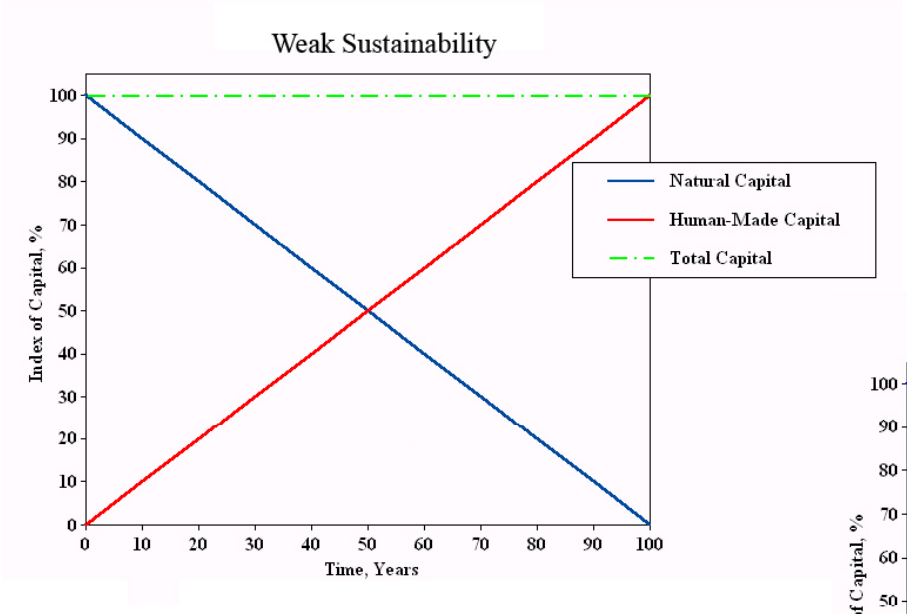
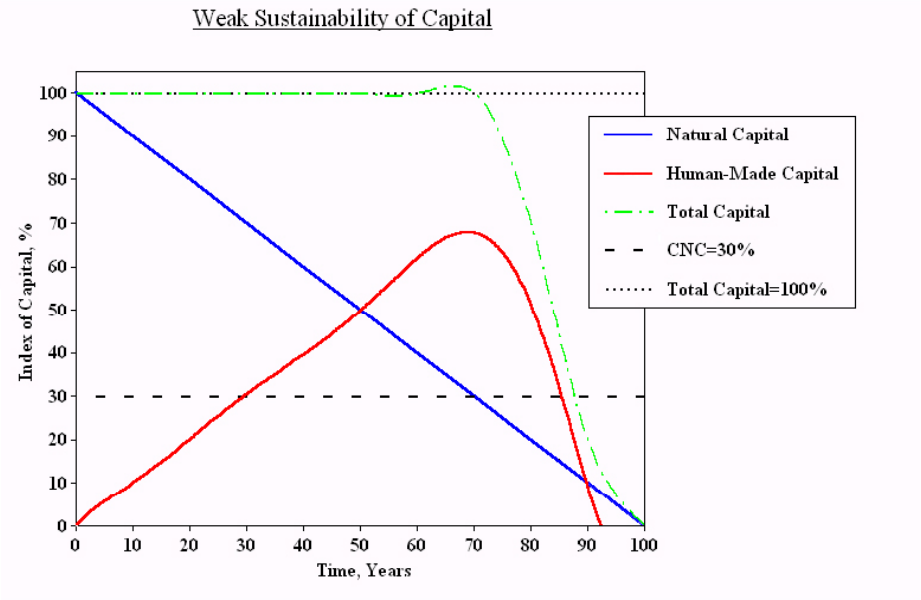
Prelude

"Understanding environmental interactions involves some of the most difficult issues in engineering, chemistry, physics and computer science. Regrettably, many environmental students are not interested in the hard stuff."

Kenneth Deffeyes (Princeton University) author of *Beyond Oil*

Mining and Sustainability





But Mining as Potential for “Strong” Sustainability

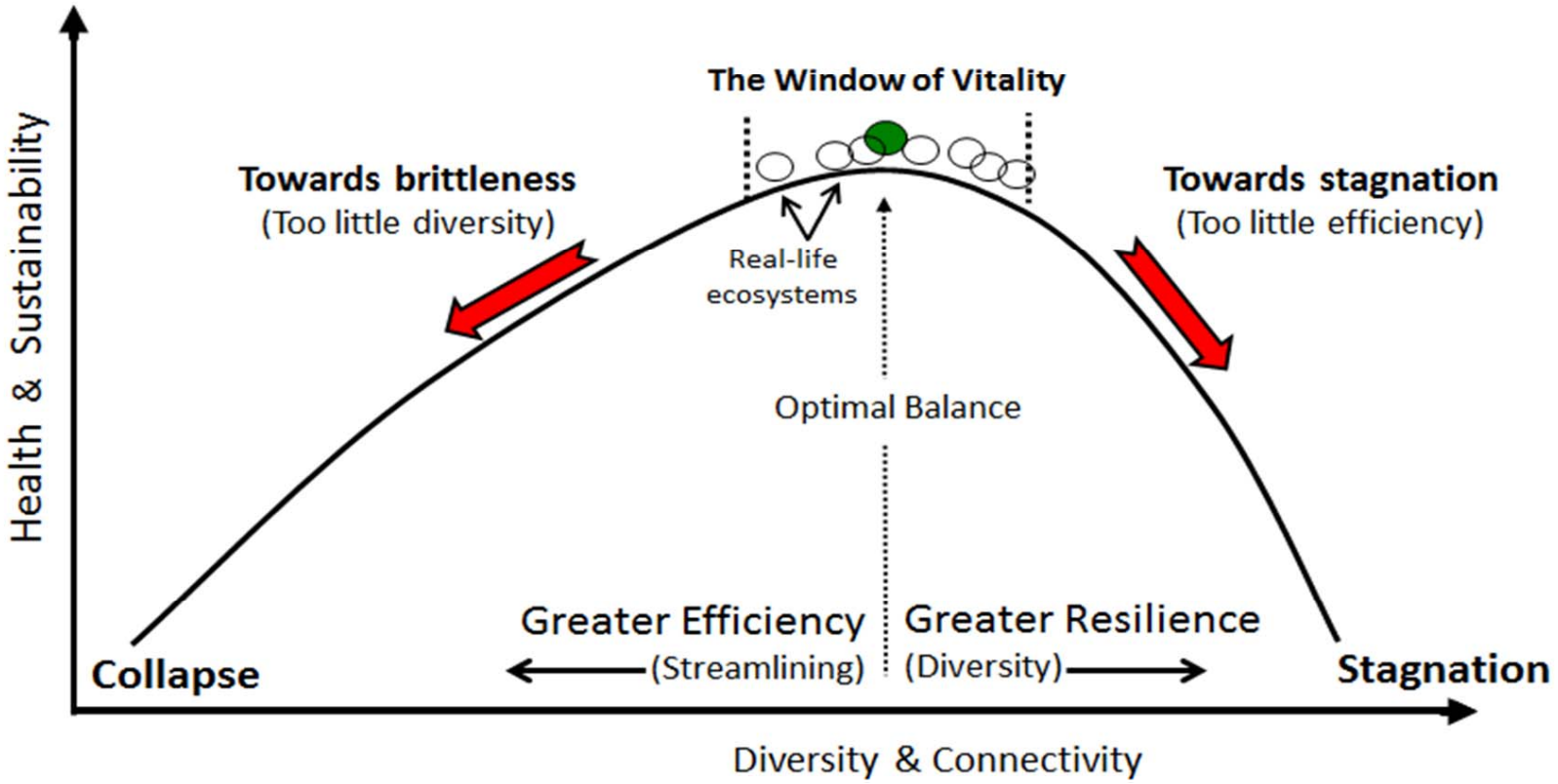
Raw Materials” are chemicals and at a purely elemental level they are renewable – it’s all a matter of how much energy and other resources such as water we are willing to invest in their retrieval.

Thus the source of the energy, water and other ingredients in resource retrieval become important in making the case for “strong sustainability”

Raw materials may be essential ingredients in technologies to induce strong sustainability such as solar panels requiring gallium arsenide or rare earths in wind turbines etc.

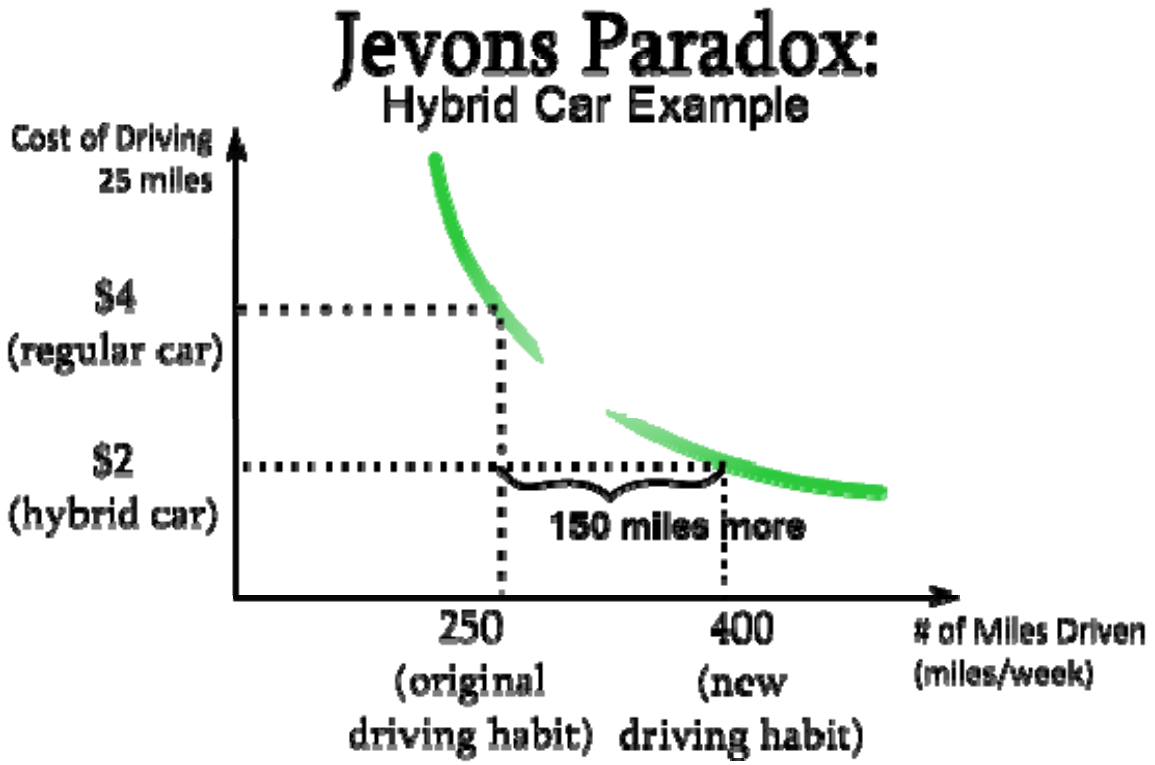
Natural ore bodies are fixed assets on human time scales and hence different from agriculture or forestry which could have irretrievably lost revenue potential from a growing season.

Resilience versus Efficiency

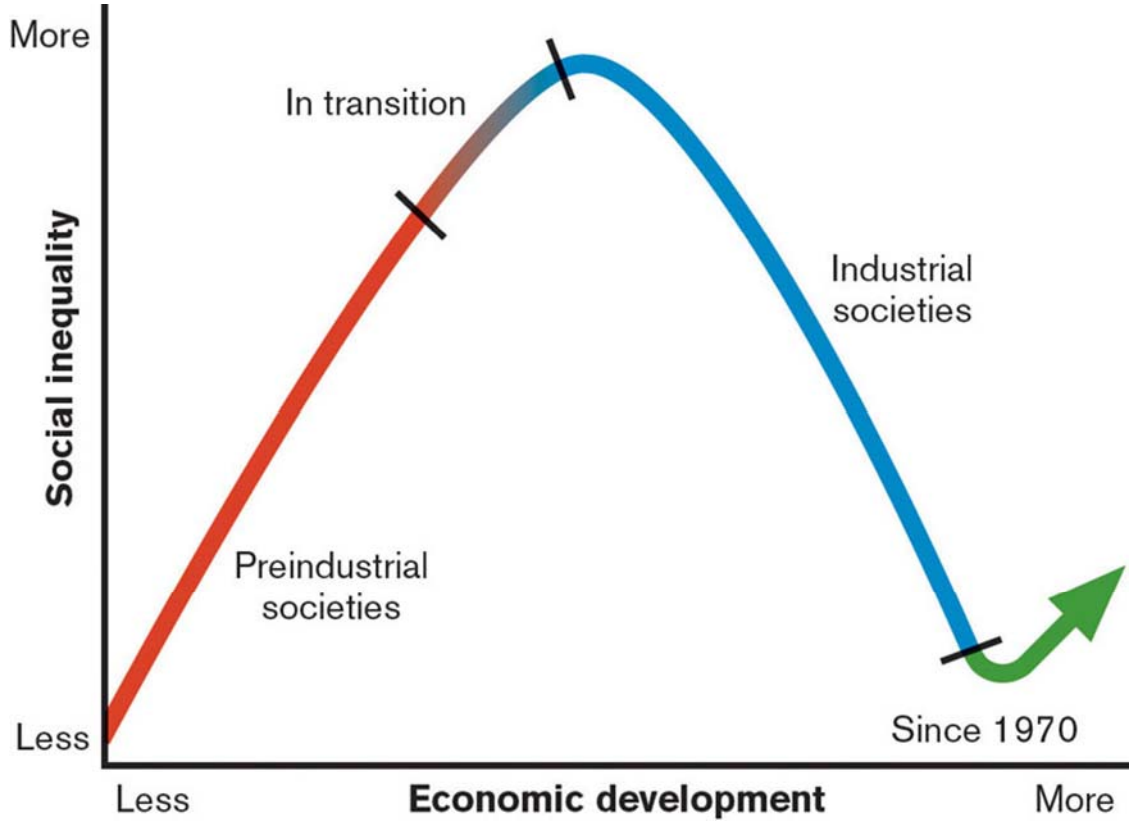


Ulanowicz, R.E., Bondavalli, C., and M.S. Egnotovich, 1996 United States Geological Service Biological Resources Division, University of Miami, Coral Gables, FL 33124.

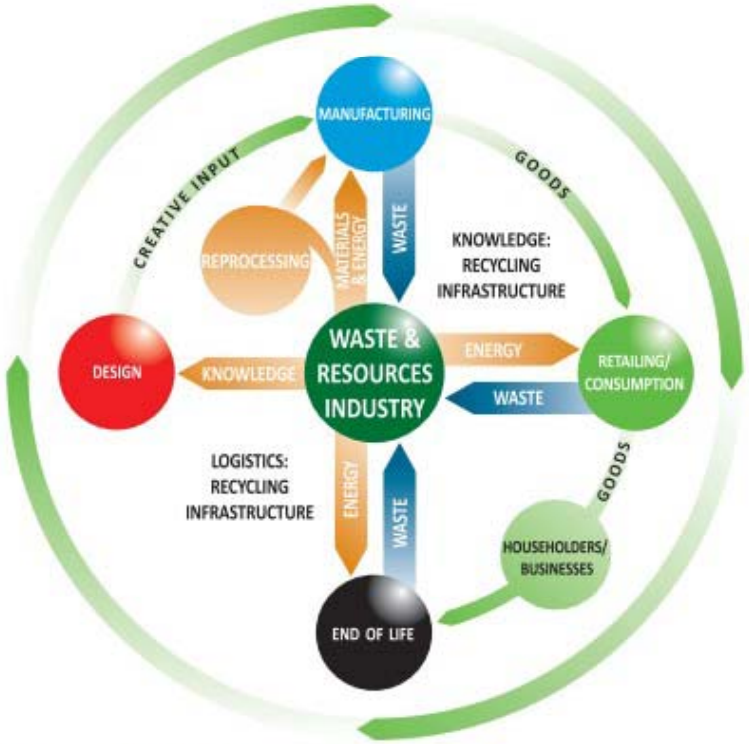
Cautionary Note on Efficiency



The Kuznets Question: Social AND Ecological Dimensions



Efficiency through Circularity?



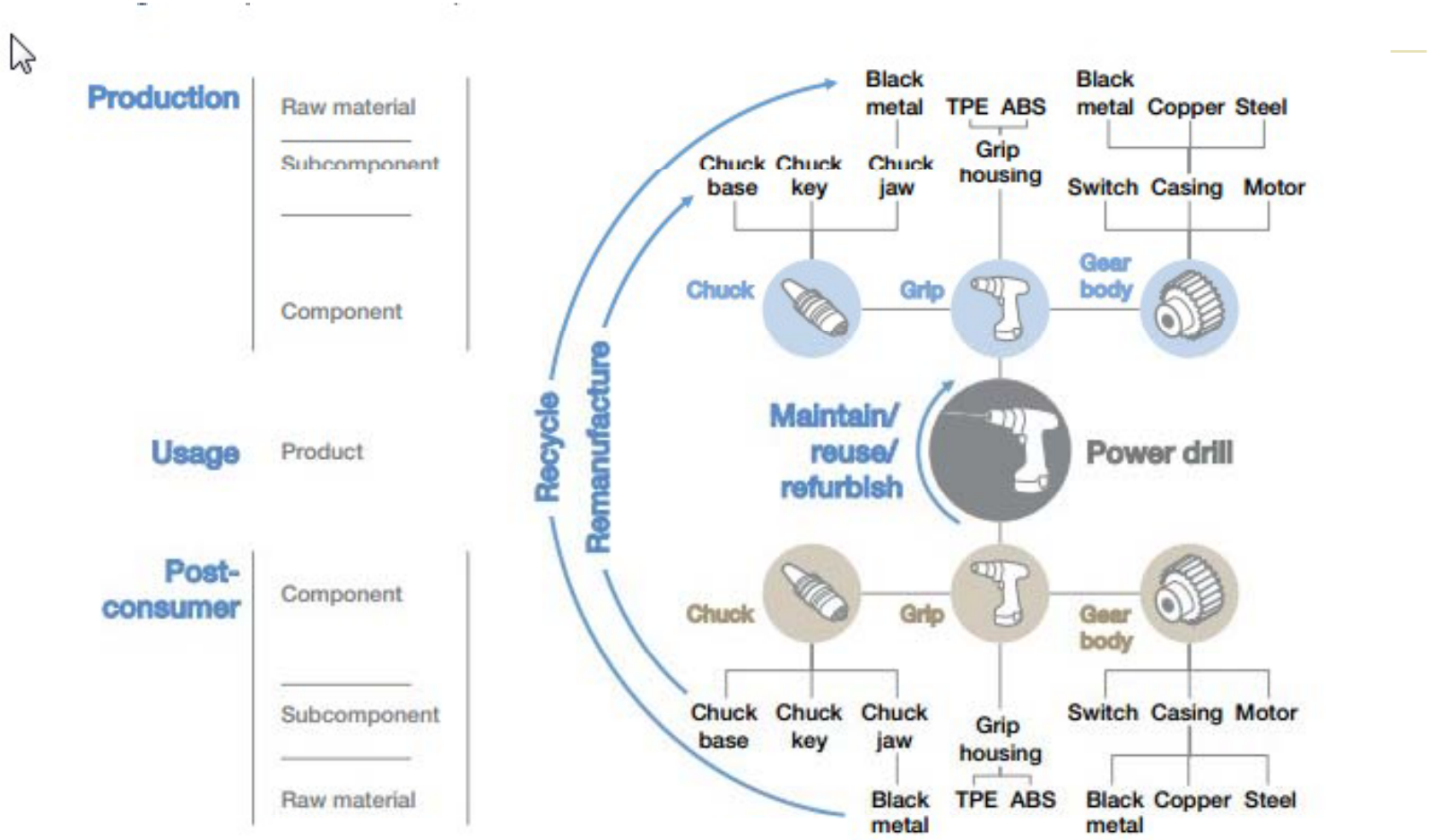
Source: ESA

[1] http://www.ellenmacarthurfoundation.org/business/ce100

[2] https://www.gov.uk/government/publications/resource-security-action-plan-making-the-most-of-valuable-materials

[3] http://www.green-alliance.org.uk/grea1.aspx?id=6571

A Circular Economy Needs a Treaty



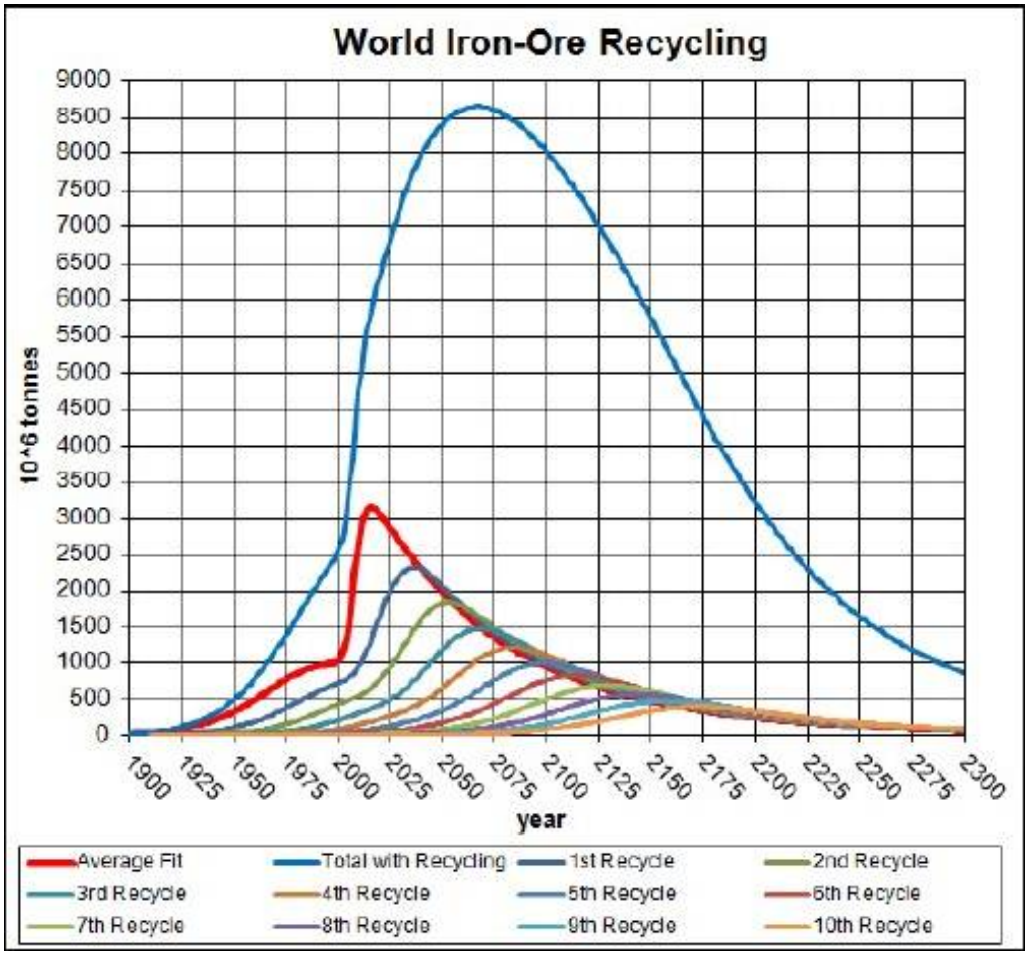
Source: Expert interviews; World Economic Forum and Ellen MacArthur Foundation circular economy team

“Urban” Mining Has Far Greater Potential for Gold but not for all minerals – but that too will change

■
10 kg

500 kg to 10,000 kg

Transforming the “Peak” Approach?



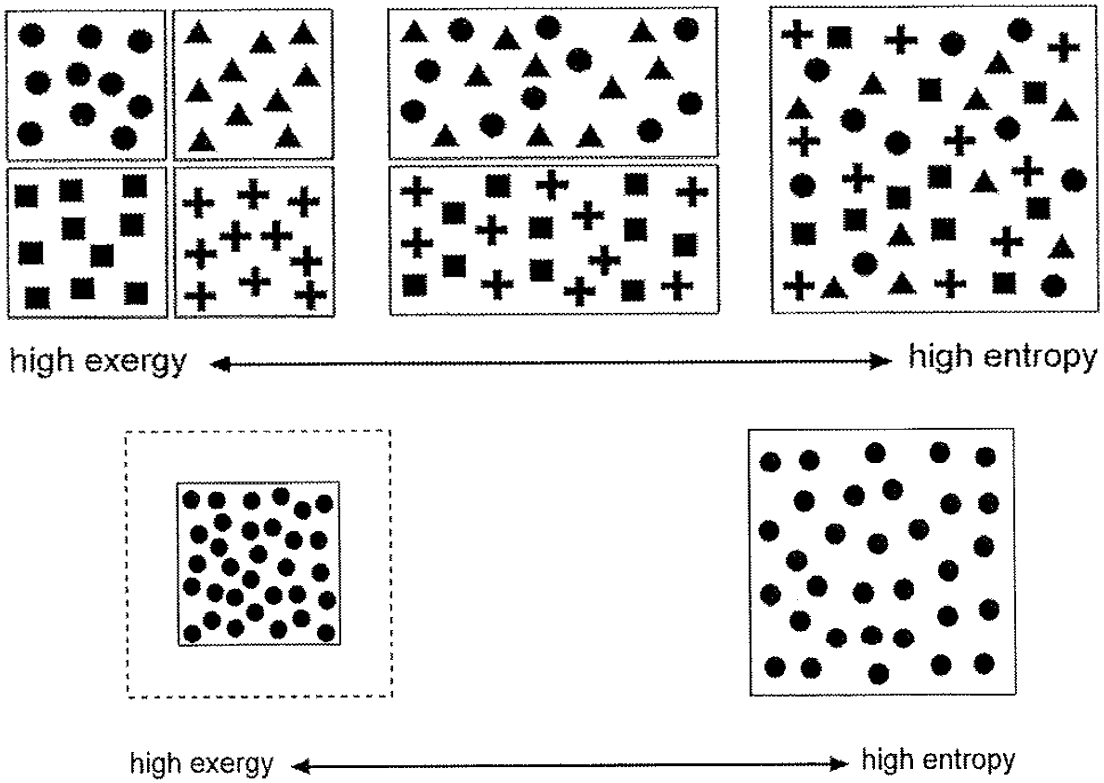
L. David Roper.
Verhulst Fit projection
Professor emeritus of Physics at Virginia Tech, 2011

Entropy, Complexity and Exergy

- Elements from a chemical perspective are indefinitely renewable, unless converted by a nuclear reaction from one element to another
- Feasibility of harnessing elements back in usable form is a question of physics and how in an open system energy can be applied to reduce entropy in that context
- Goal of high complexity and low entropy

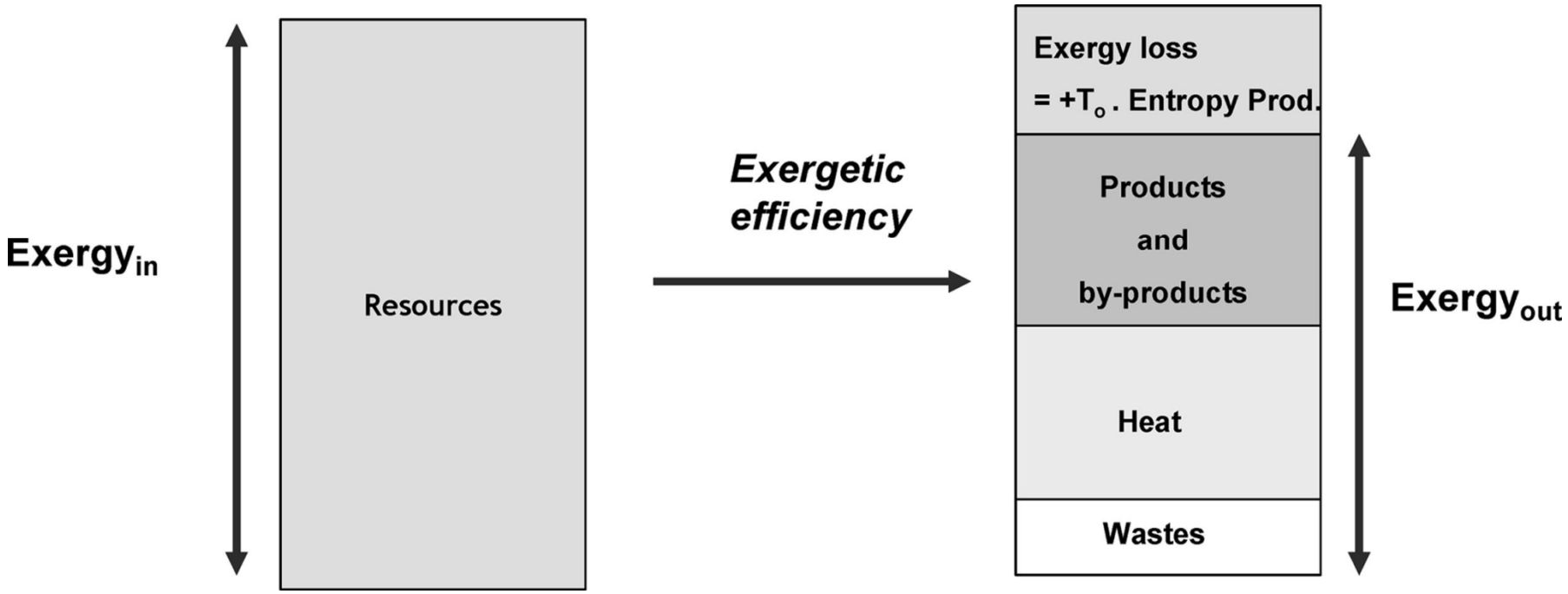
Should we stockpiling end-of-use products with embedded minerals that could be utilized later when economic geological conditions allow for their usage? Printed Circuit Boards

Clarifying Metrics

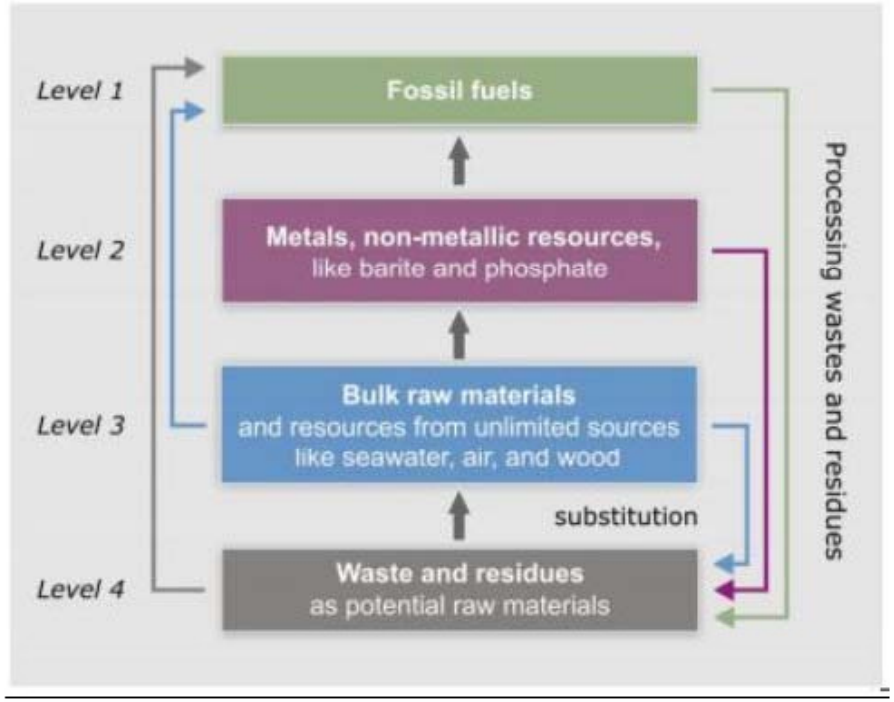


Stremke, Sven, Andy van den Dobbelsteen, and Jusuck Koh. 2011. "Exergy Landscapes: Exploration of Second-law Thinking Towards Sustainable Landscape Design." *International Journal of Exergy* 8 (2): 148-174.

Using exergy metrics



Dewulf, Jo, Herman Van Langenhove, Bart Muys, Stun Bruers, Bhavik R. Bakshi, Geoffrey F. Grubb, D. M. Paulus, and Enrico Sciubba. 2008. "Exergy: Its Potential and Limitations in Environmental Science and Technology." *Environmental Science & Technology* 42 (7) (April 1): 2221-2232.



Steinbach, Volker and Friedrich-W. Wellmer 2010. "Consumption and Use of Non-Renewable Mineral and Energy Raw Materials from an Economic Geology Point of View." *Sustainability* 1408-1430.

Two “Deficit” areas

- Demand is absent for goods and services that have most livelihood potential: Development paths of particular economies with limited alternatives may suggest specific trajectories that are most viable from a sustainable livelihoods perspective but for which there is limited demand.

- Trade Needs Analysis: The Natural Resources inventory and related metrics may also lead to particular trade inputs for the success of a particular product. Trade linkages across the planet could be analyzed using tools from complex systems research to propose an optimal strategy that minimizes ecological impacts while providing maximum livelihood potential

LIVELIHOOD CHALLENGE

Central challenge to reconciling jobs and the environment is the tension between durable resource development, which generally supports ecological metrics, and disposable product development which supports more reliable employment

7 Questions to Sustainability – Revisiting MMSD

- 1. **Engagement:** Are communities part of the negotiation process for any development effort?
- 2. **People:** Will the well- being of inhabitants in the area be maintained or improved, as mea sure by objective welfare criteria?
- 3. **Environment:** Is the integrity of the environment ensured over the long term?
- 4. **Economic viability:** Is the project or operation economically viable, and will the community be better off as a result of the project in the long term?
- 5. **Traditional and nonmarket activities:** Are livelihood potentials, such as subsistence hunting, going to be adequately protected during the course of the project?
- 6. **Institutional arrangements and governance:** Are rules, incentives, programs,

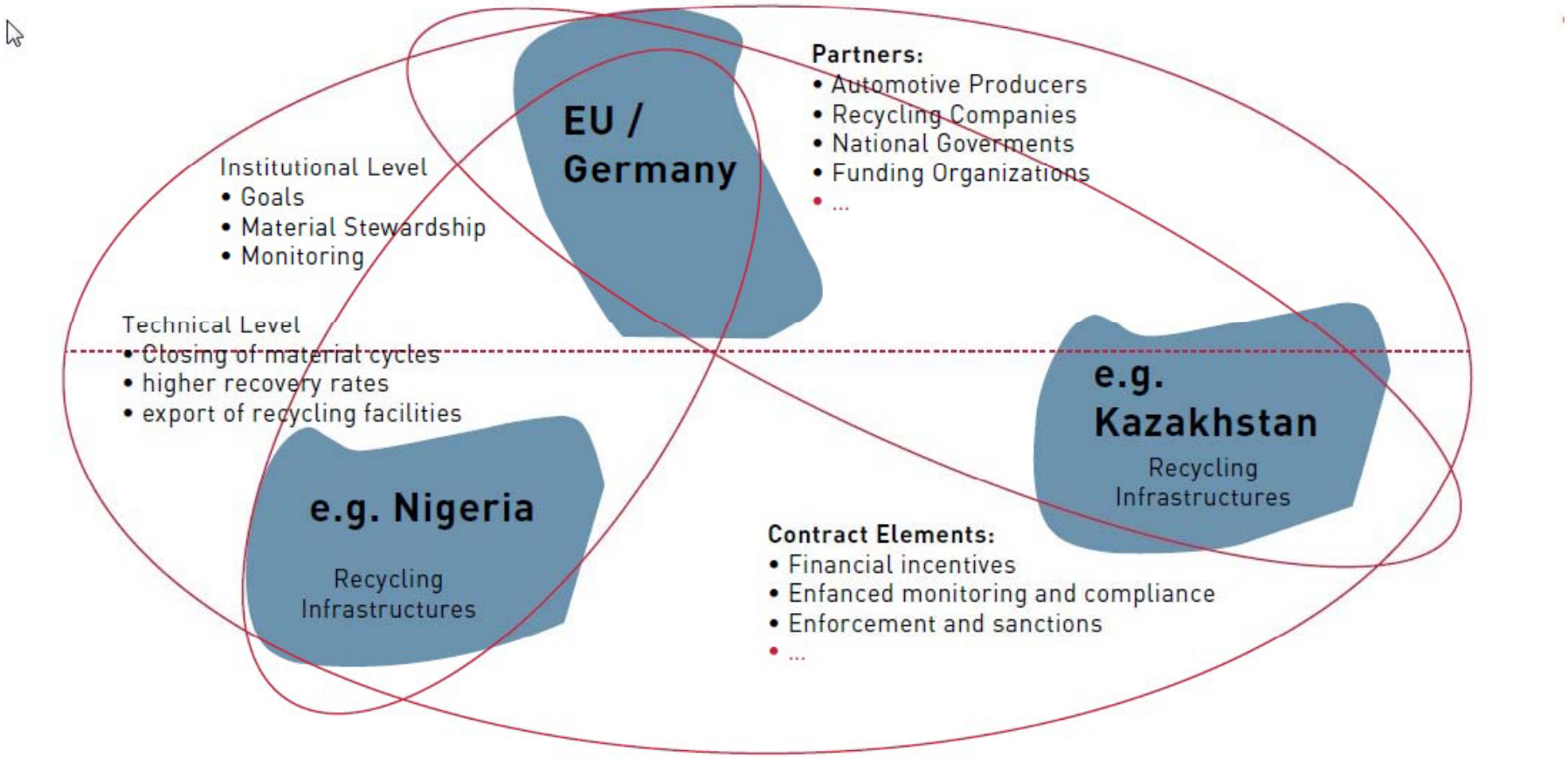
and capacities in place to address project or operational consequences?

- 7. **Synthesis and continuous learning:** Does a comprehensive analysis show the net outcome of the project to be positive, and how will periodic assessment validate this finding through the course of the project?

Possible POLICY Product

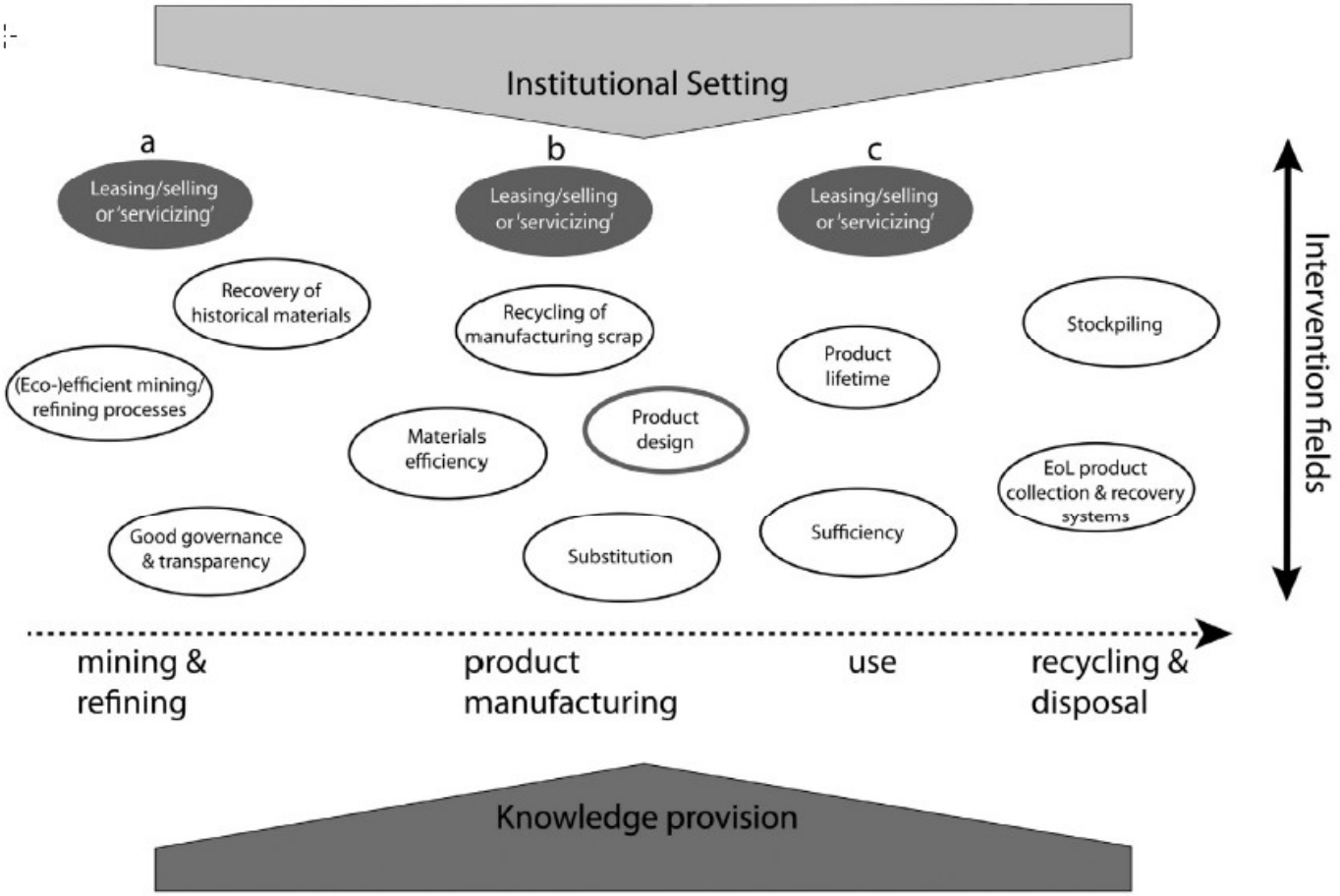
- Sustainable Livelihood Assessment based on Mines to Markets analysis
- “Elemental Accounting” system: *Many of us know what is inside our cereal boxes and other food items thanks to labeling guidelines, but how many of us know what elements are inside our computers or our clothes? In the coming decade consumers, regulators, and businesses must become much more "elementally aware," so that decisions on making, breaking, and remaking products can be more prudently budgeted.*

Proposal for a Mineral “Covenant”



Wilts, H., R. Bleischwitz & J. Sanden (2010). *Ein Covenant zur Schließung internationaler Stoffkreisläufe im Bereich Altautorecycling [A covenant for the closure of international material flows in the field of end of life vehicle recycling].* Resource efficiency paper 3.5. Wuppertal Institut

Lithium example



Prior T, et al, Sustainable governance of scarce metals: The case of lithium, Sci Total Environ (2013), http://dx.doi.org/10.1016/j.scitotenv.2013.05.042

Coda

"The study of the substances of the earth's crust, of the air over and the waters under earth, which has led to our present knowledge has been more adventurous than many a great journey. . . . Into the unknown world of things upon the "sea that ends not till the world's end" scientists ventured, and came back laden with treasure greater than all the gold and precious stones ever taken from the earth."

Robert E. Rose, *The Foundations of Chemical Industry, 1924*

Epigraph in Ali, Saleem H. *Treasures of the Earth: Need, Greed and a Sustainable Future.* Yale University Press, 2010