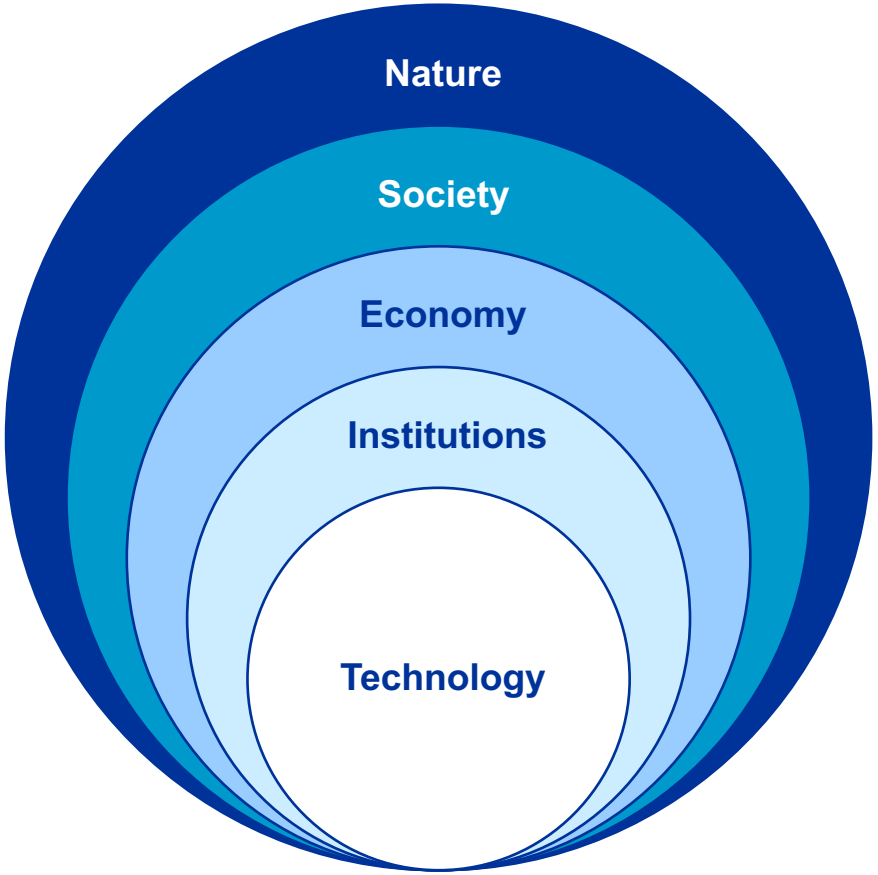
Professional Practice

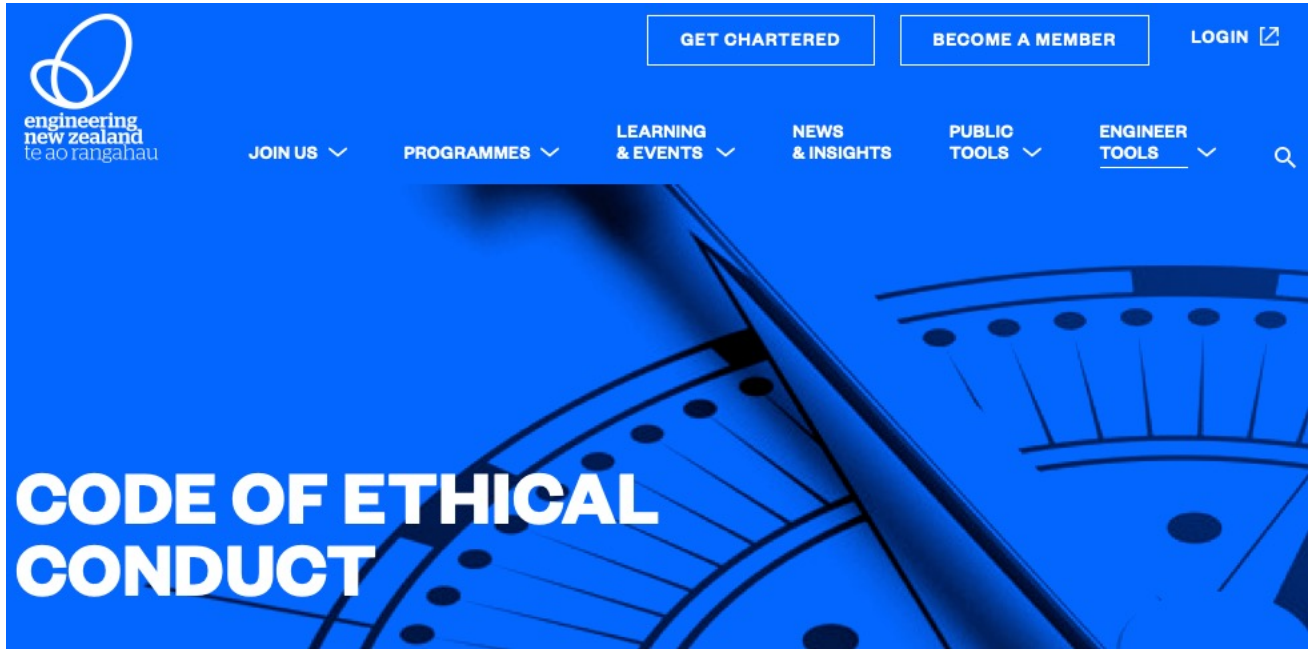
Sustainability

the sustainability society
a technical interest group of
engineering new zealand

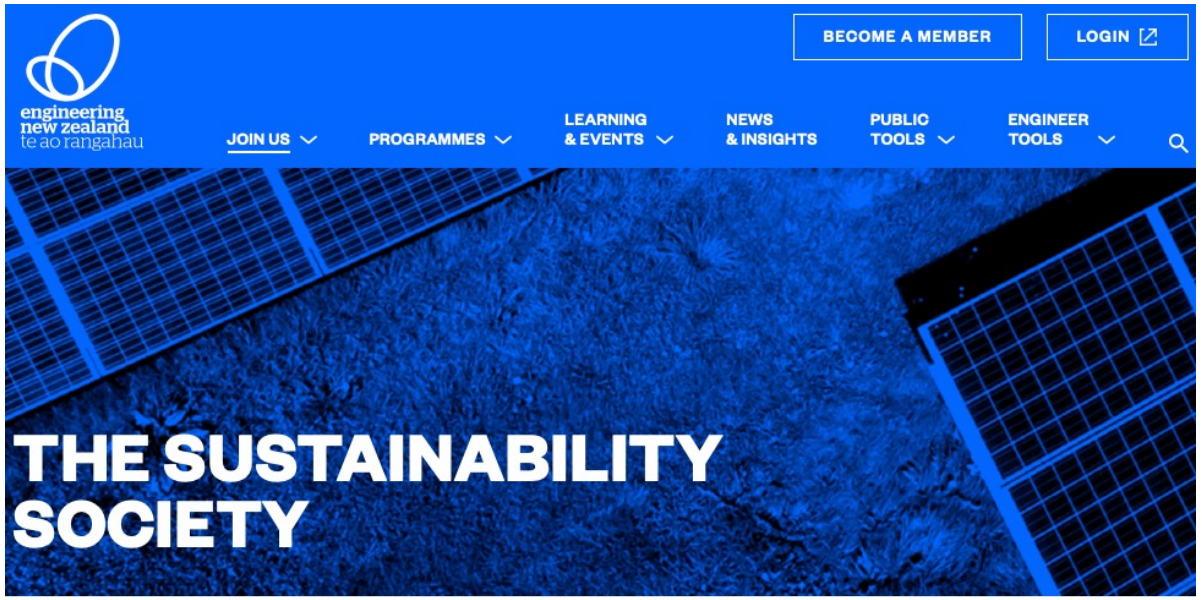
Prof Alan Brent
Sustainable Energy Systems Group



- Take reasonable steps to safeguard health and safety
- Have regard to effects on environment
- Report adverse consequences
- Act competently
- Behave appropriately
- Inform others of consequences of not following advice
- Maintain confidentiality
- Report breach of Code



Engineering New Zealand TSS



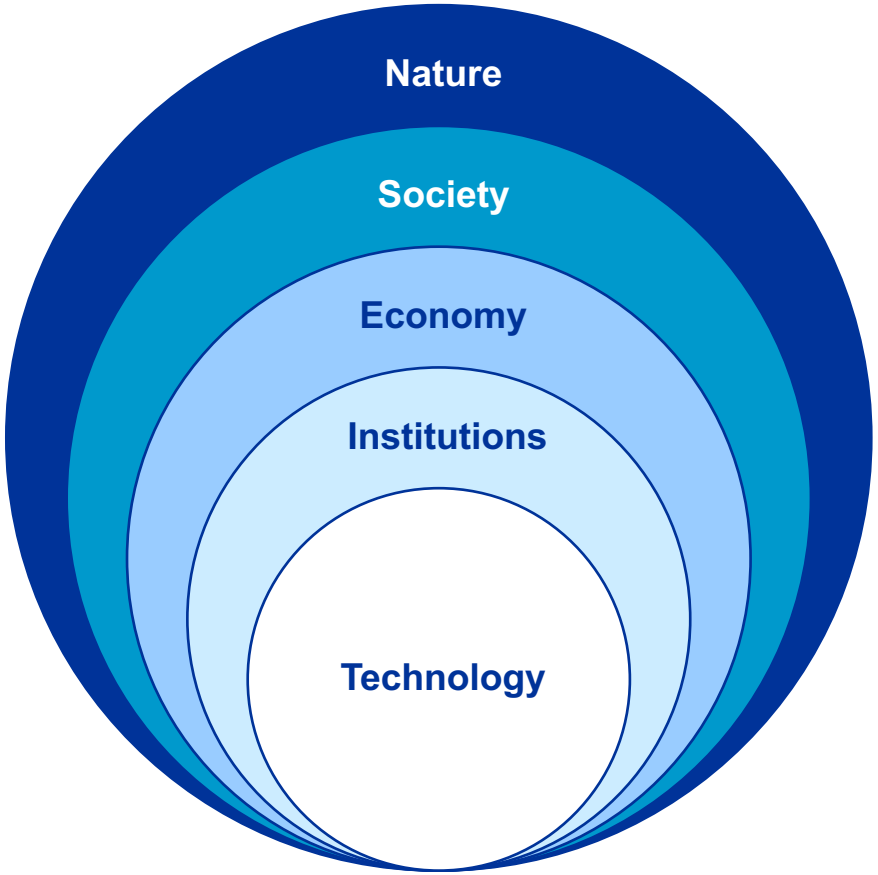
The Sustainability Society (TSS) is an national network established to foster sustainability within the built environment. They have a complex systems approach to sustainability, recognising that human and natural systems are interconnected and interdependent. Formed in 2003, TSS is a technical group of Engineering New Zealand.

Sustainable development

- Most often defined as meeting the needs of the present without compromising the ability of future generations to meet theirs.

- It has three main pillars: economic, environmental, and social.
  - Or people, planet and profits.

- SDGs is now our lens/framework for considering the way forward:

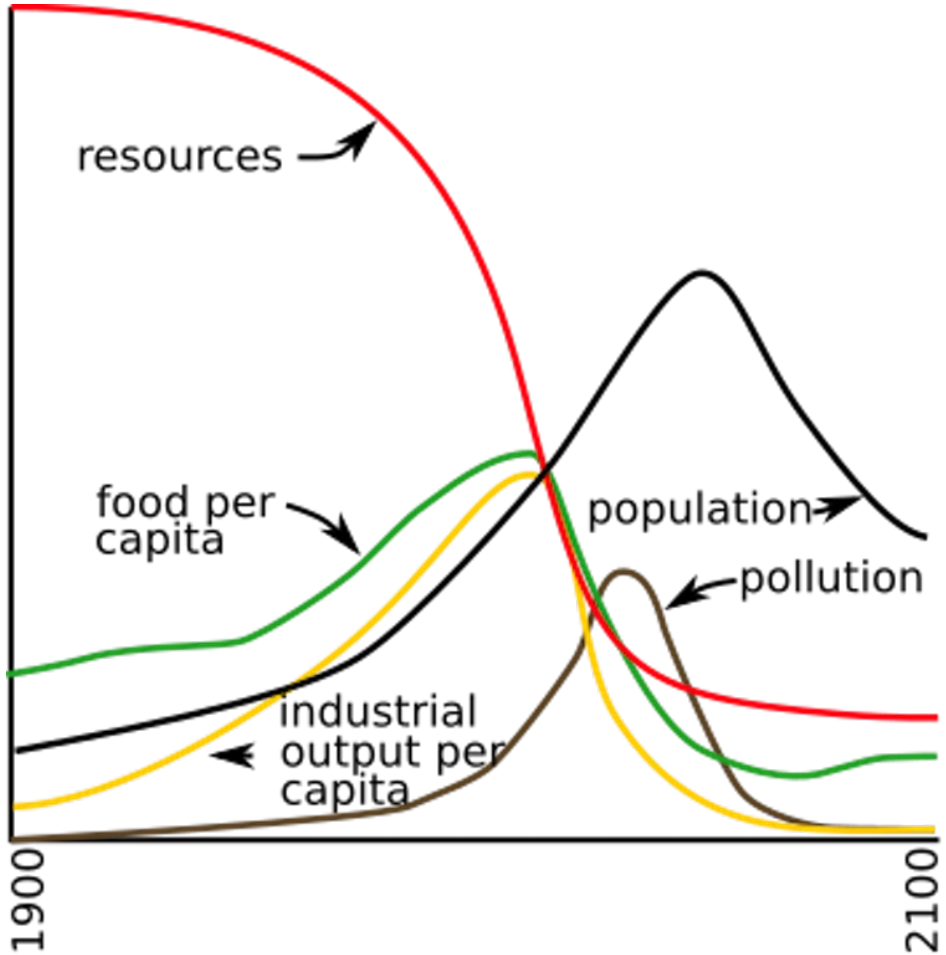


Sustainable Development Goals

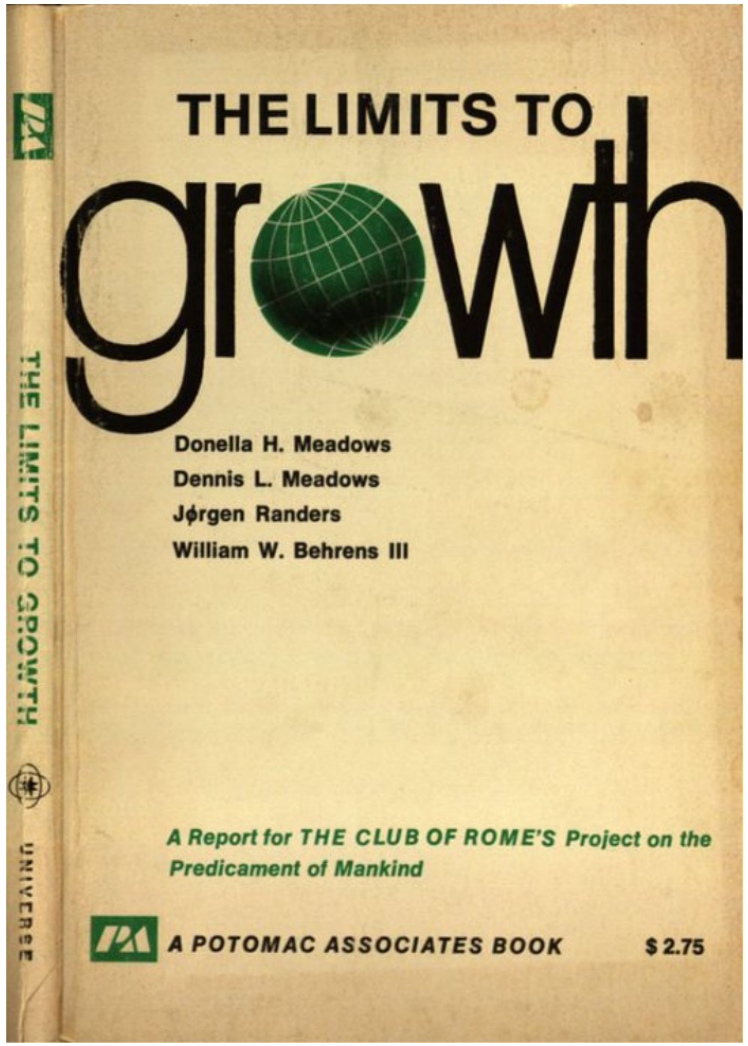
Principles to achieve sustainable development

- Ensuring a strong, healthy and just society.
- Promoting good governance.
- Achieving a sustainable economy.
- Using sound science responsibly.
- Living within environmental limits.

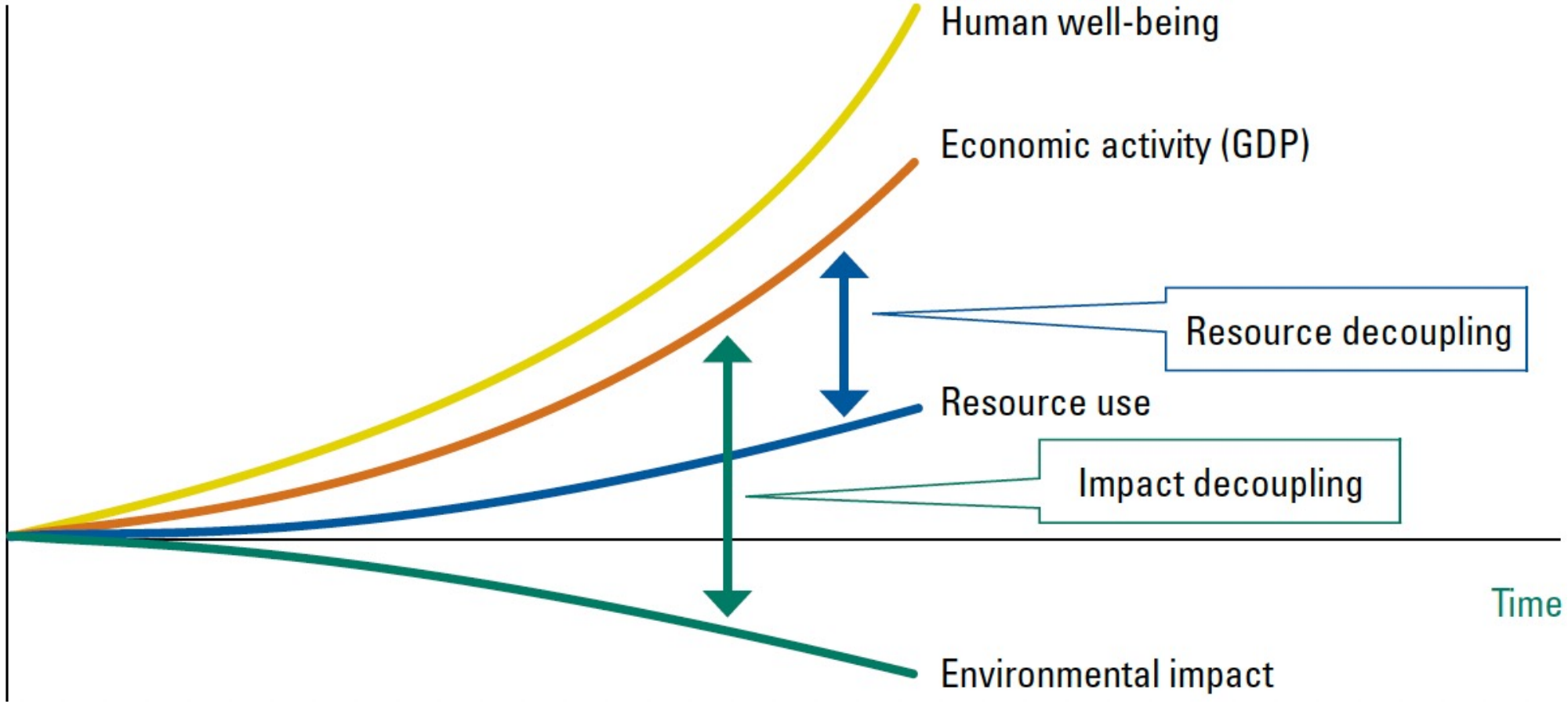
Green Growth vs. Degrowth



Meadows et al., 1972

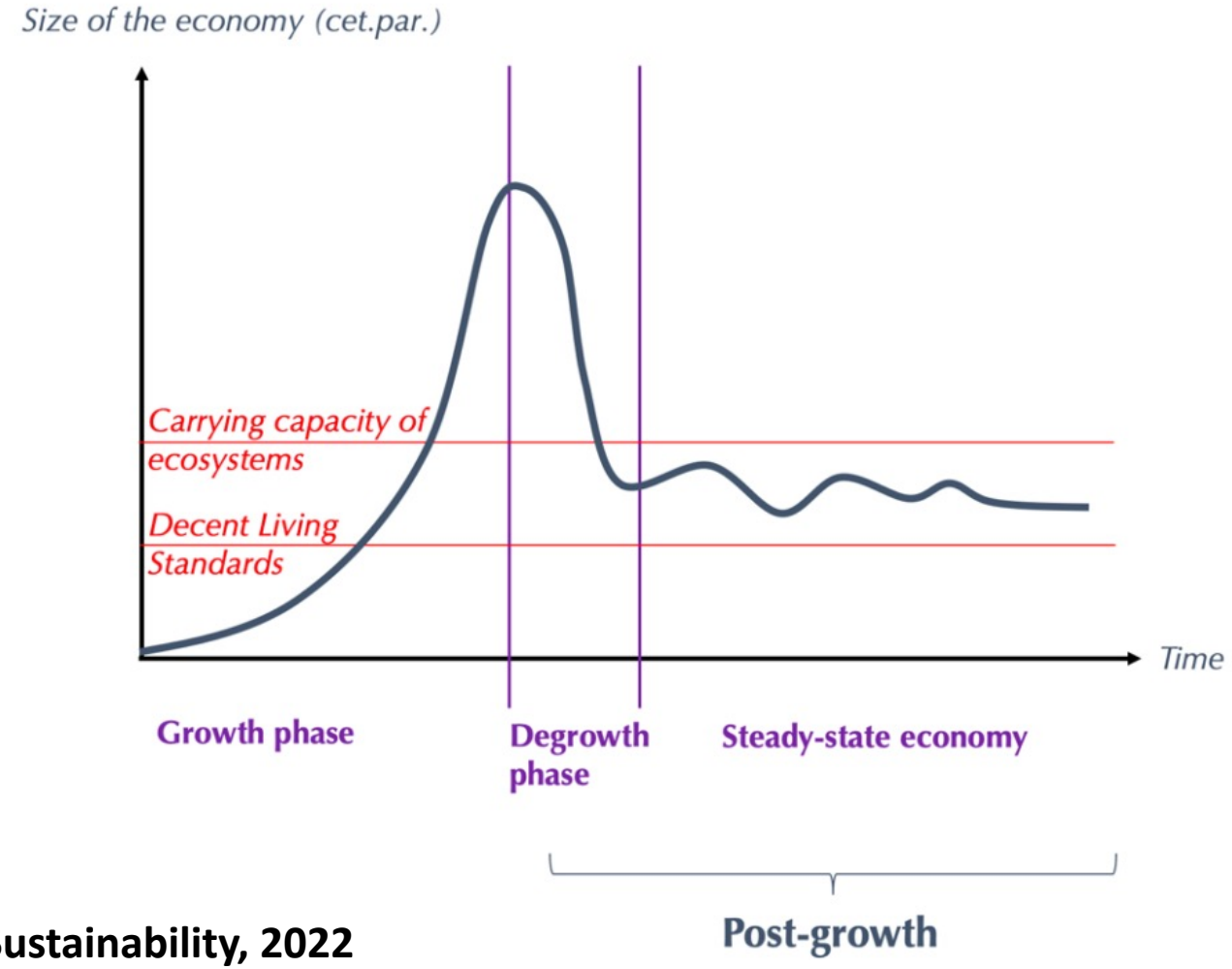


Green Growth vs. Degrowth



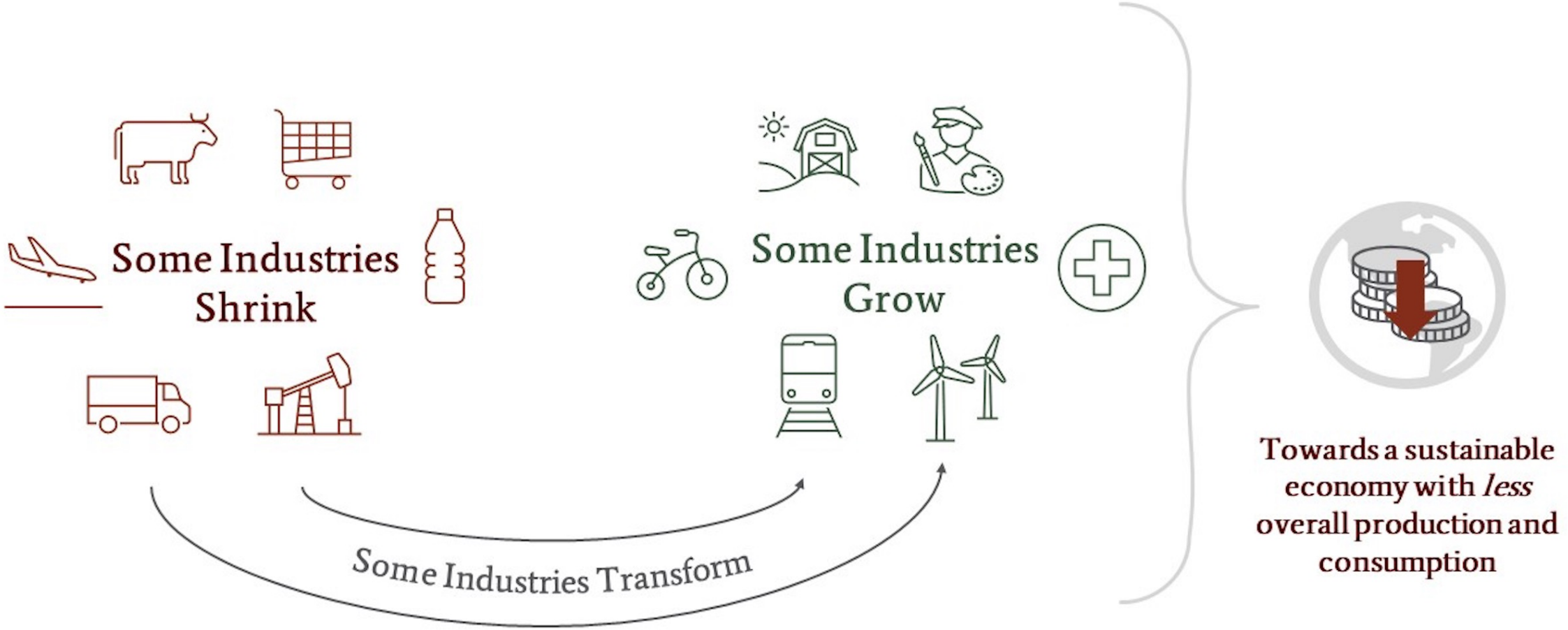
United Nations Environment Programme, 2011

Green Growth vs. Degrowth



Network for Business Sustainability, 2022

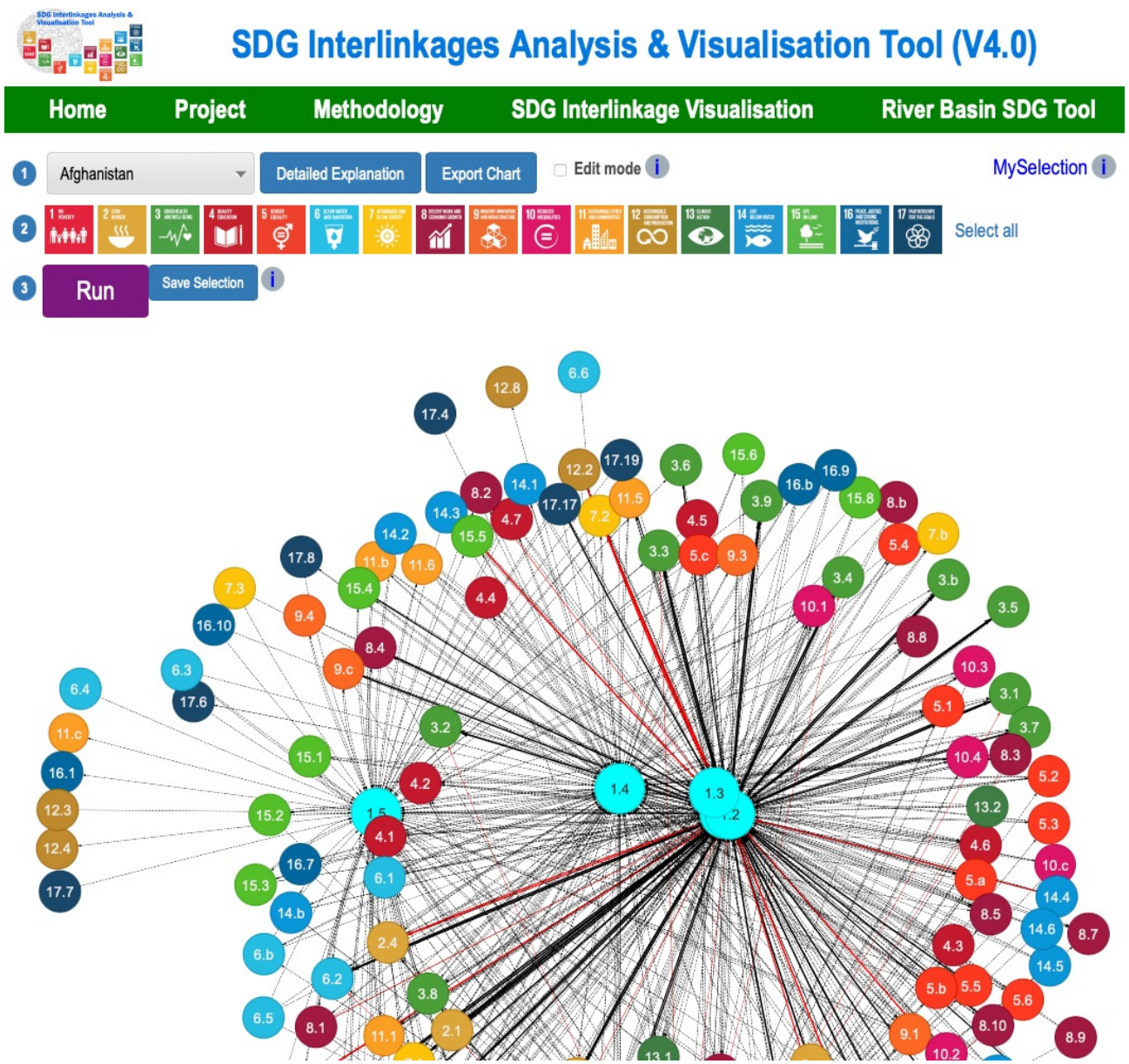
Green Growth and Degrowth



Network for Business Sustainability, 2022

Six principles for professional engineers

- Contribute to building a sustainable society, present and future.
- Apply professional and responsible judgement and take a leadership role.
- Do more than just comply with legislation and codes.
- Use resources efficiently and effectively.
- Seek multiple views to solve sustainability challenges.
- Manage risk to minimise adverse impact to people or the environment.



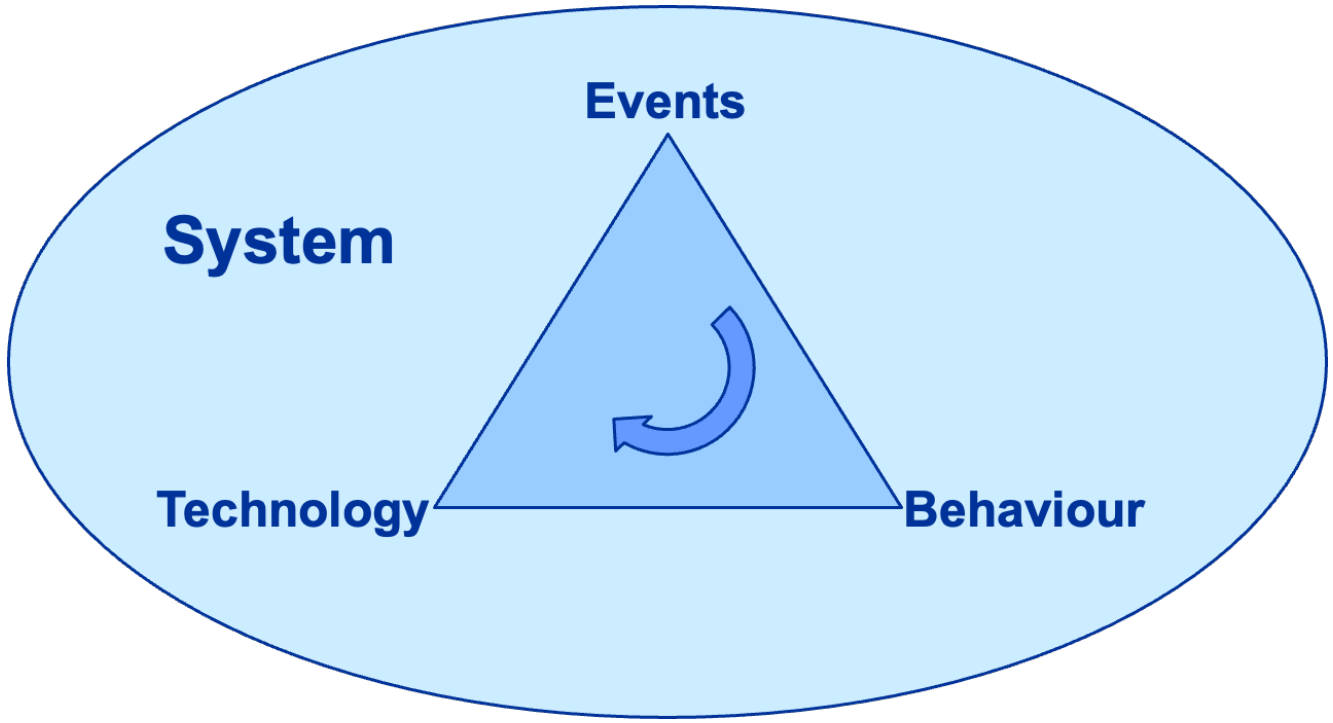
CAPITAL THINKING.
GLOBALLY MINDED.
MAI I TE IHO KI TE PAE

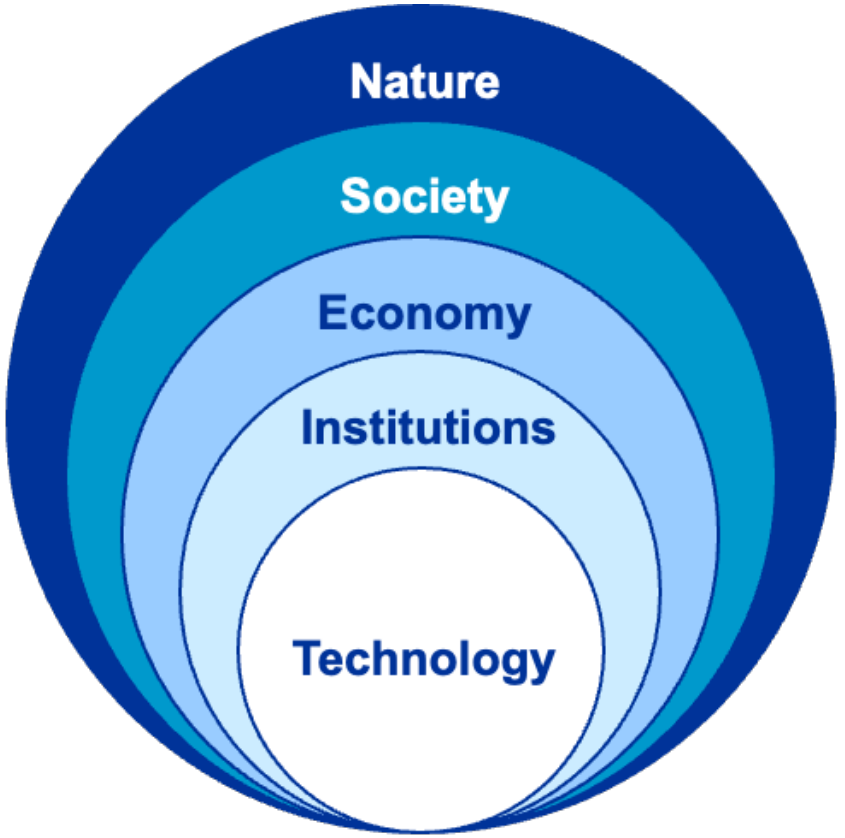
KAITIAKITANGA WHAKAPAPA MAURI

http://www.wgtn.ac.nz/sustainable-energy-systems

1897 VICTORIA UNIVERSITY OF WELLINGTON TE HERENGA WAKA

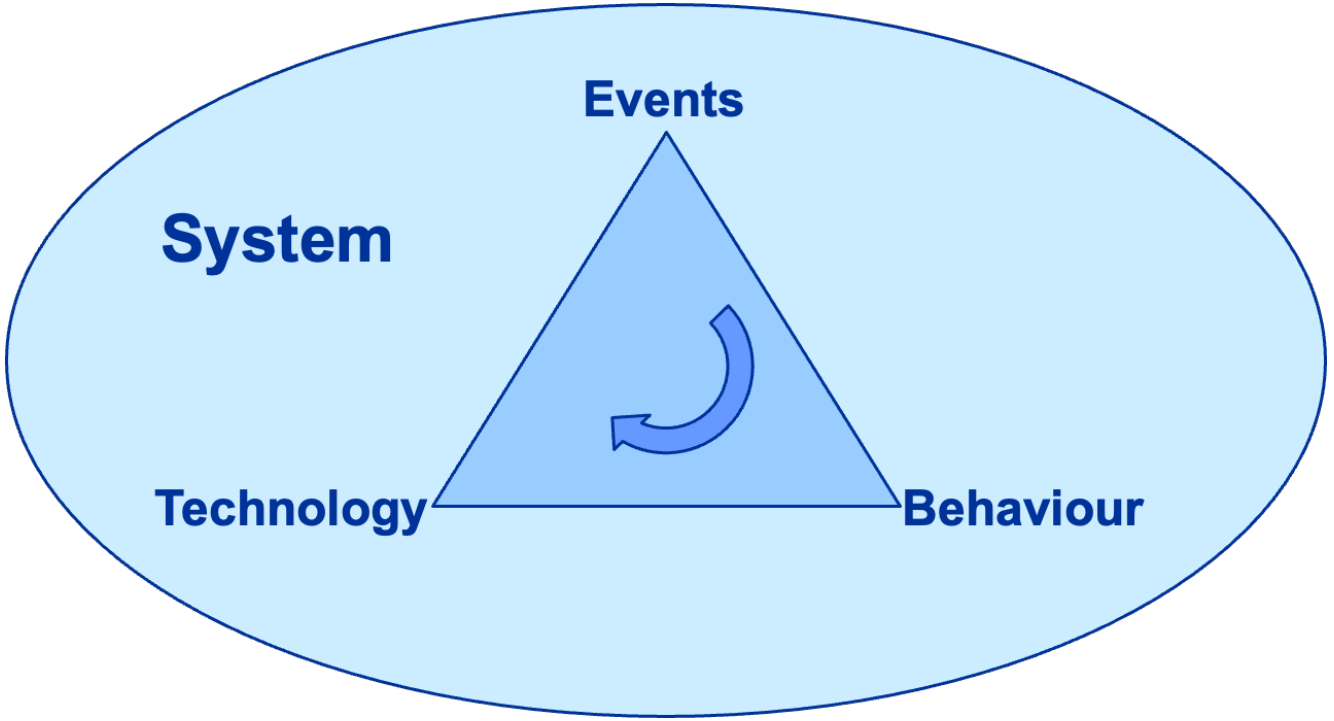
Need a systems perspective





Concepts of a ‘system’

- A system is regarded as a “whole” consisting of interacting “parts”
  - Bertalanaffy, 1950, 1968

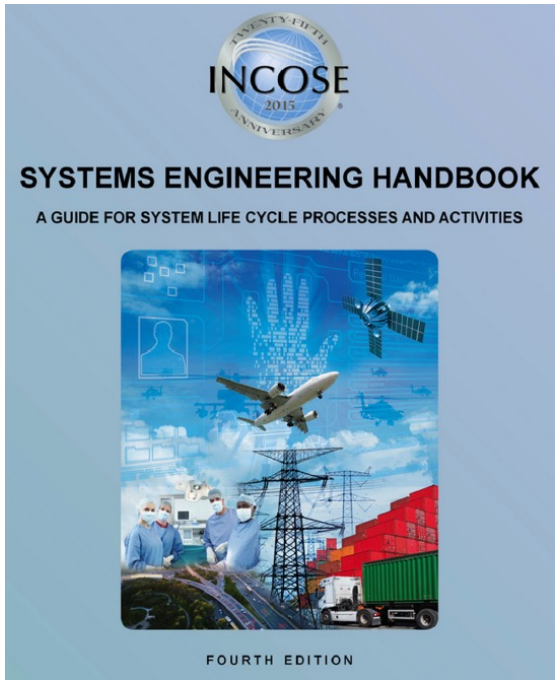


Concepts of a ‘system’: SE perspective

- A set of detailed methods, procedures and routines created to carry out a specific activity, perform a duty, or solve a problem
- An organized, purposeful structure that consists of interrelated and interdependent elements (components, entities, factors, members, parts etc.)
- These elements continually influence one another (directly or indirectly) to maintain their activity and the existence of the system, in order to achieve the goal of the system

Concepts of a ‘system’: Elements of a system

- Products (hardware, software, firmware)
- Processes (e.g., technical review process)
- People (e.g. operators & maintainers)
- Procedures (e.g., operator instructions)
- Information (or knowledge)
- Techniques
- Facilities
- Services
- Other support elements
  - INCOSE



Concepts of a ‘system’: Views of a system

- There are internal and external views of a system:
  - External view
    - What does not belong to the system, but does interact with the system (e.g., the operating environment or context) and can include the users (or operators)
  - Internal view
    - What belongs to the system
- The views of a system give rise to the concept of a system boundary
  - A line of demarcation between the system itself and its greater context

Concepts of a ‘system’: Functionality of a system

- Expressed in terms of the interactions of the system with its operating environment
- This leads to the concept of:
  - System architecture
    - The fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution

Concepts of a ‘system’: Functionality of a system

- Expressed in terms of the interactions of the system with its operating environment
- This leads to the concept of:
  - Engineering
    - The practice of creating and sustaining services, systems, devices, machines, structures, processes, and products to improve the quality of life
      - Getting things done efficiently and effectively

Concepts of a ‘system’: Functionality of a system

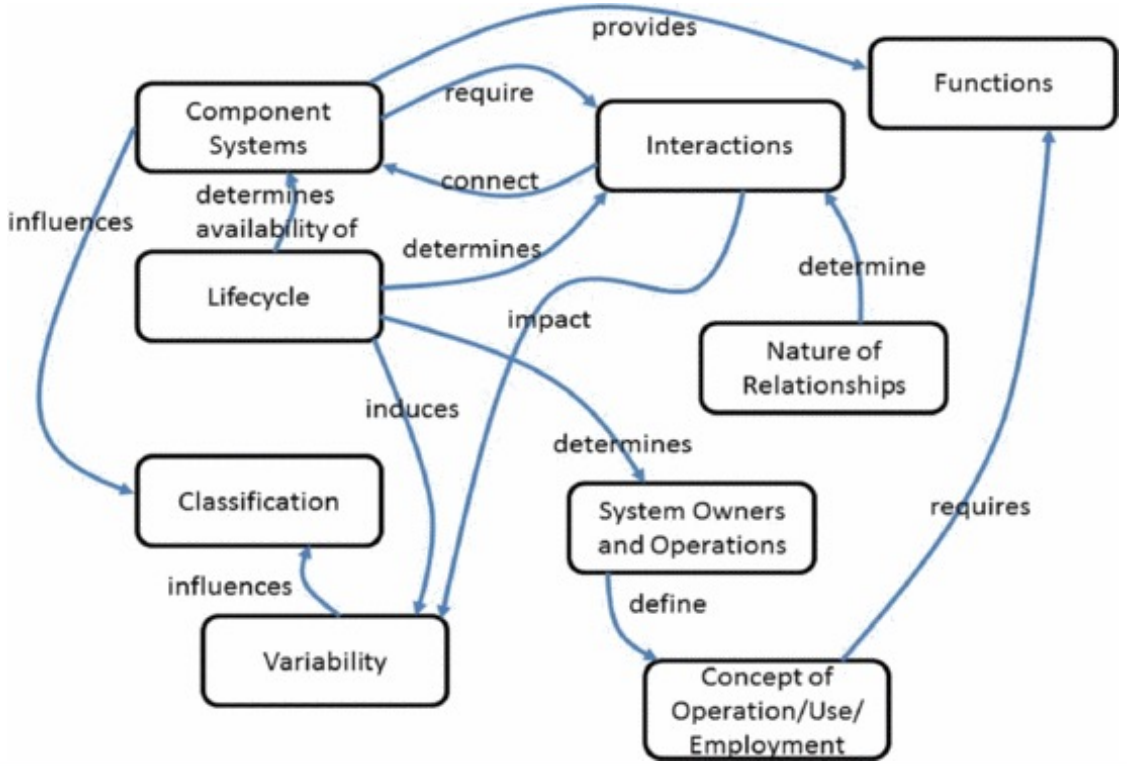
- Expressed in terms of the interactions of the system with its operating environment
- This leads to the concept of:
  - Attribute
    - An observable characteristic of a system (or element)
  - Variable
    - A symbol or name that identifies an attribute

Concepts of a ‘system’: Functionality of a system

- Expressed in terms of the interactions of the system with its operating environment
- This leads to the concept of:
  - Measurement
    - The outcome of a process in which the system of interest (SOI) interacts with an observation system under specified conditions

Concepts of a ‘system’: System Of Interest (SOI)

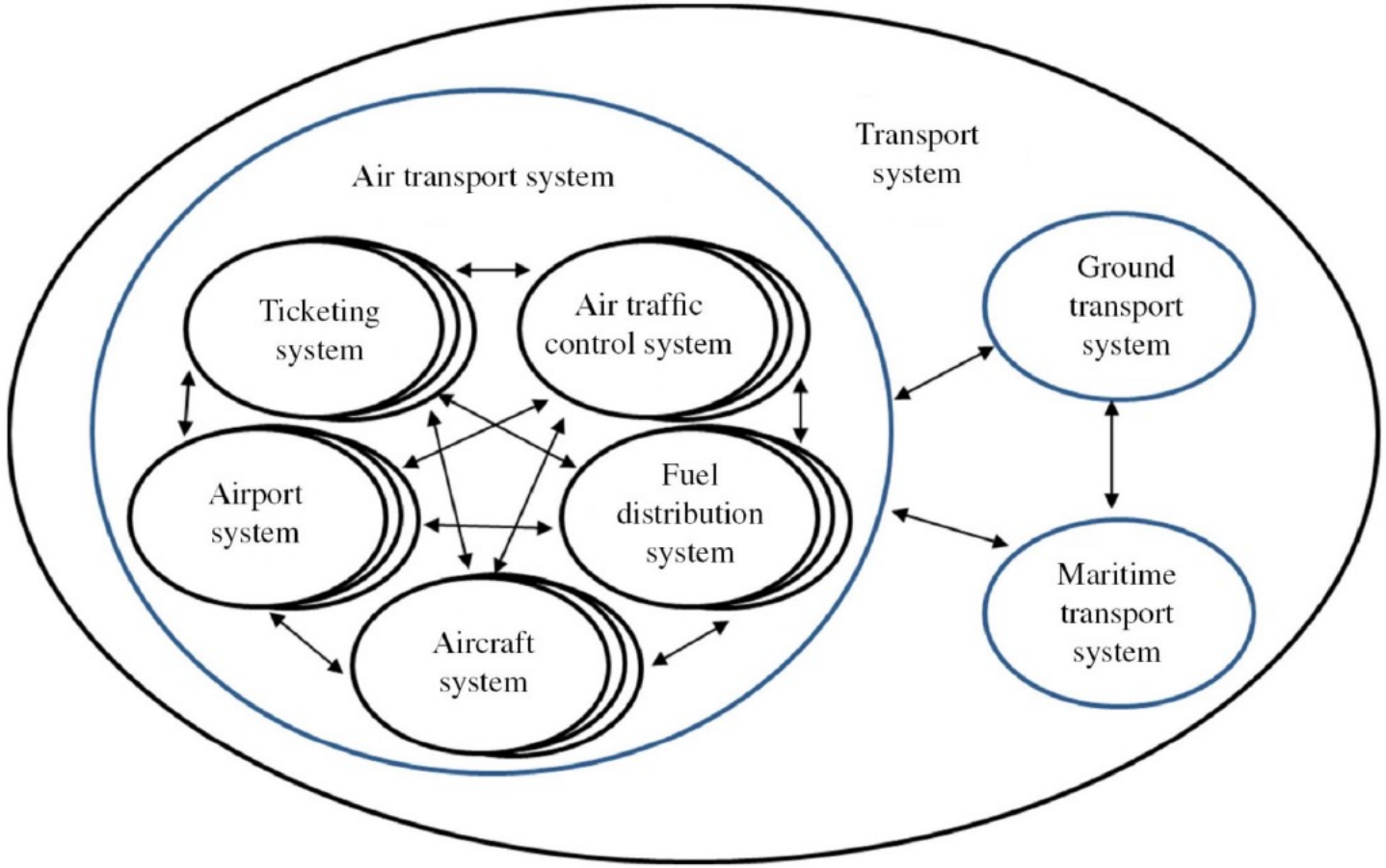
- “The system of systems whose life cycle is under consideration described by all dimensions that contribute to the resultant emergent behaviour”
  - Complicated vs. Complex



Concepts of a ‘system’: Functionality of a system

- Expressed in terms of the interactions of the system with its operating environment
- This leads to the concept of:
  - Dynamic behaviour
    - The time evolution of the system state
  - Emergent behaviour
    - Behaviour that can’t be understood exclusively in terms of the behaviour of the individual system elements

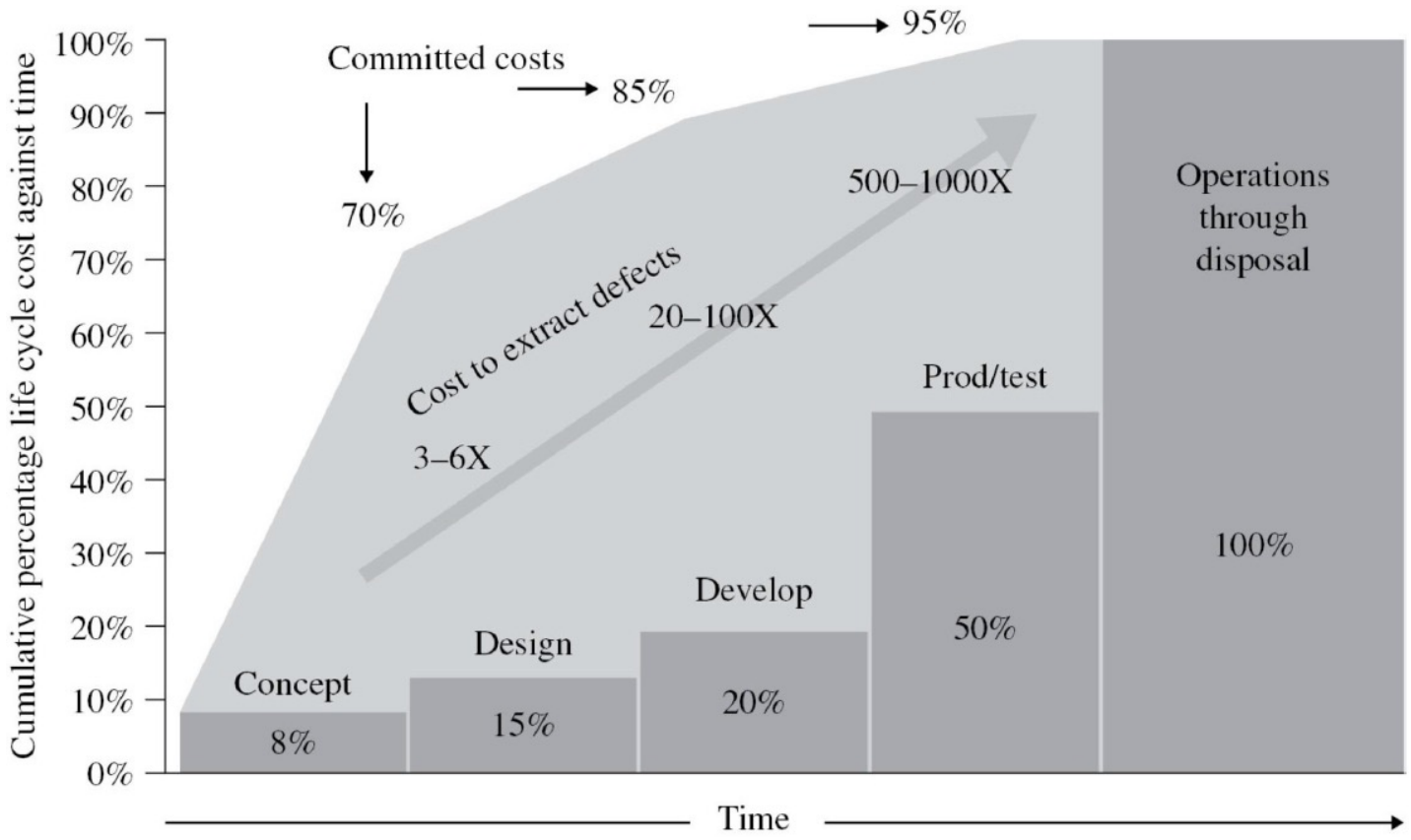
Concepts of a ‘system’: SoS example



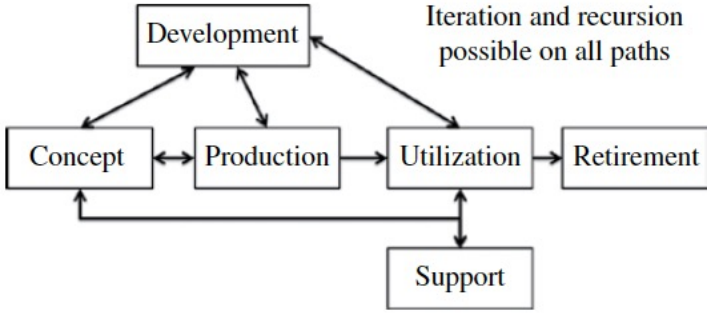
In summary

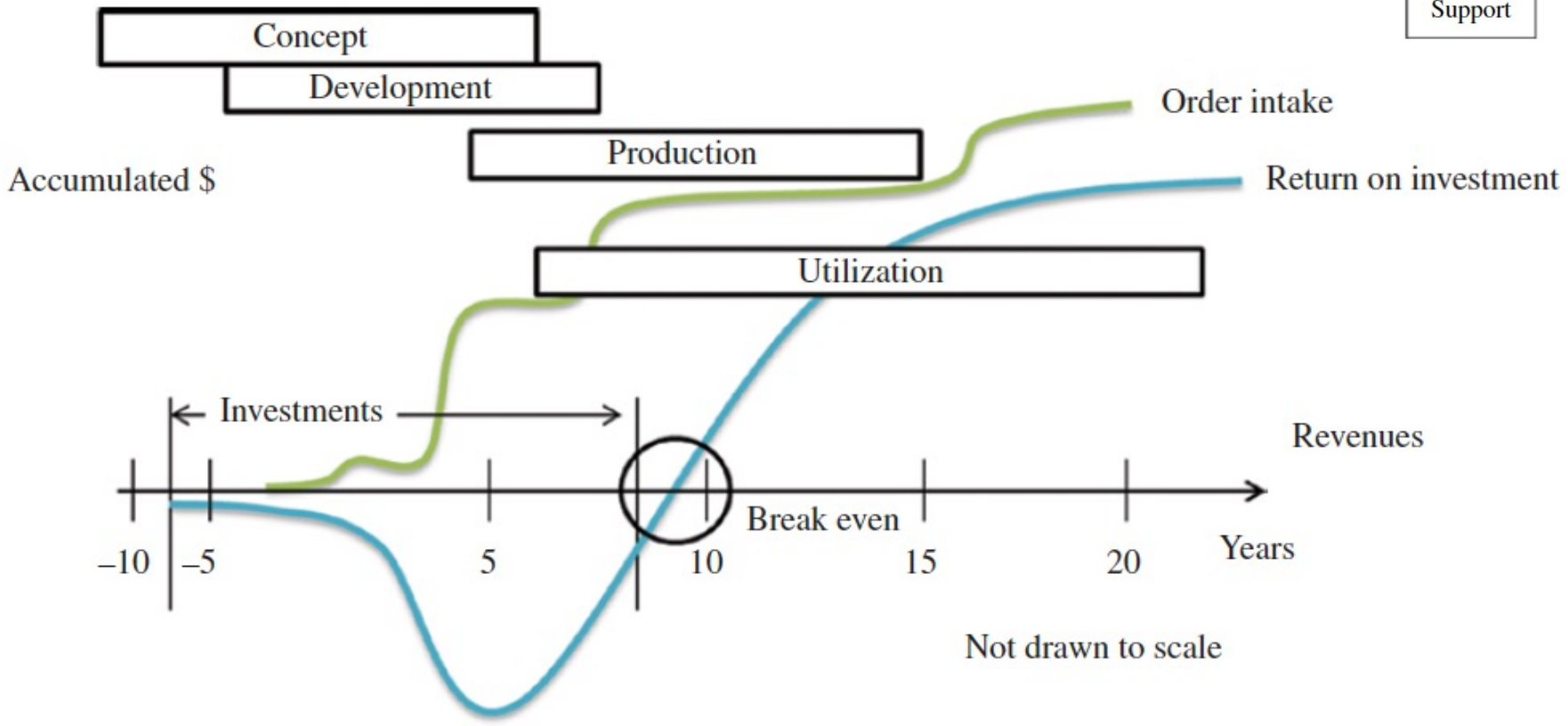
Systems tend to…	Systems of systems tend to…
Have a clear set of stakeholders	Have multiple levels of stakeholders with mixed and possibly competing interests
Have clear objectives and purpose	Have multiple, and possibly contradictory, objectives and purpose
Have a clear management structure and clear accountabilities	Have disparate management structure with no clear accountability
Have clear operational priorities, with escalation to resolve priorities	Have multiple, and sometimes different, operational priorities with no clear escalation routes
Have a single lifecycle	Have multiple lifecycles with elements being implemented asynchronously
Have clear ownership with the ability to move resources between elements	Have multiple owners making individual resourcing decisions

Why a systems engineering approach?

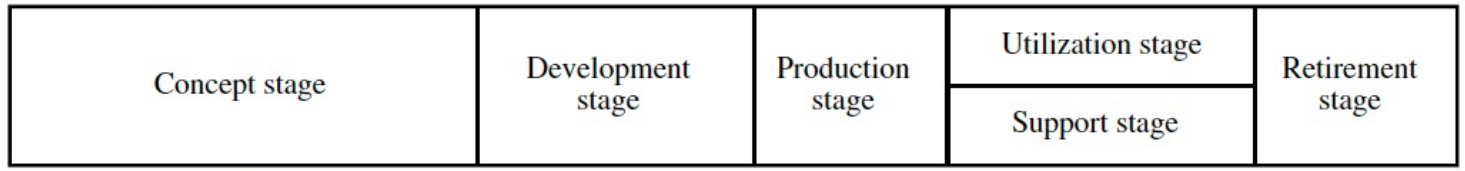


Generic business life cycle

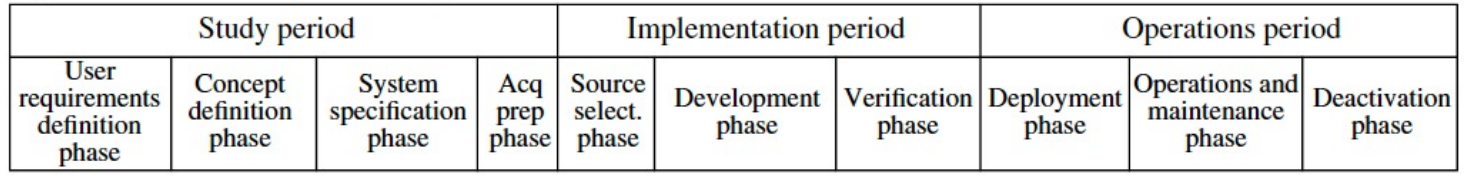




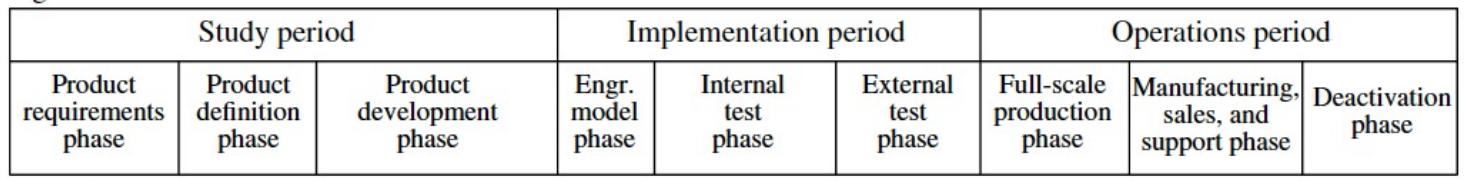
Generic life cycle (ISO/IEC/IEEE 15288:2015)



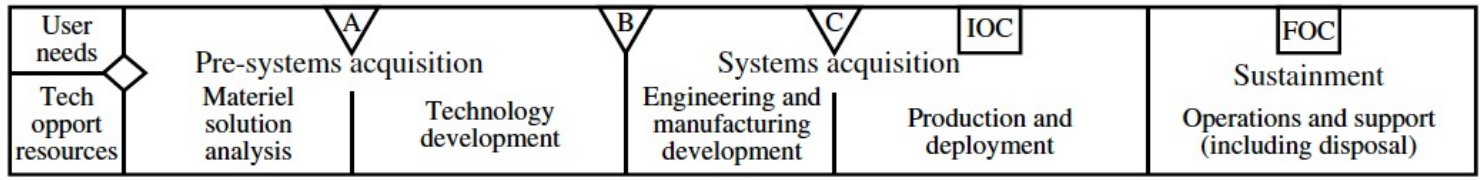
Typical high-tech commercial systems integrator



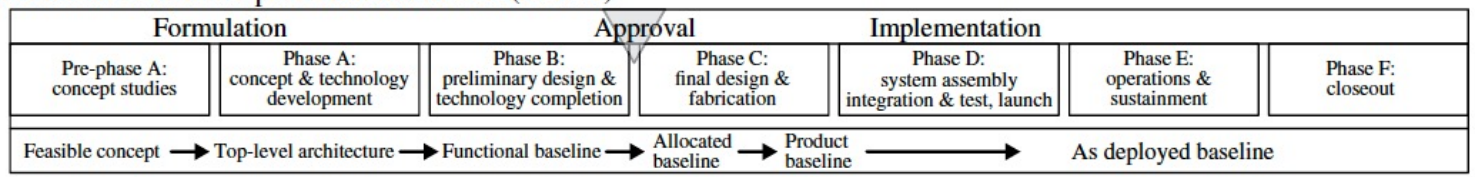
Typical high-tech commercial manufacturer



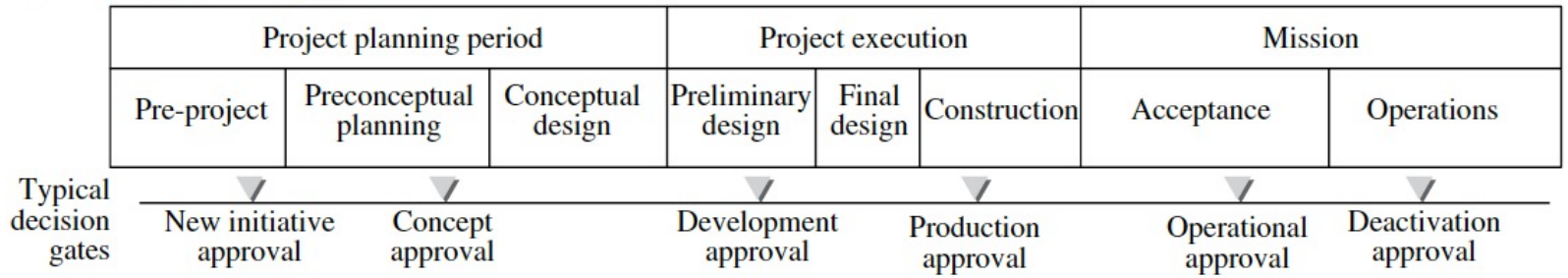
US Department of Defense (DoD)



National Aeronautics and Space Administration (NASA)



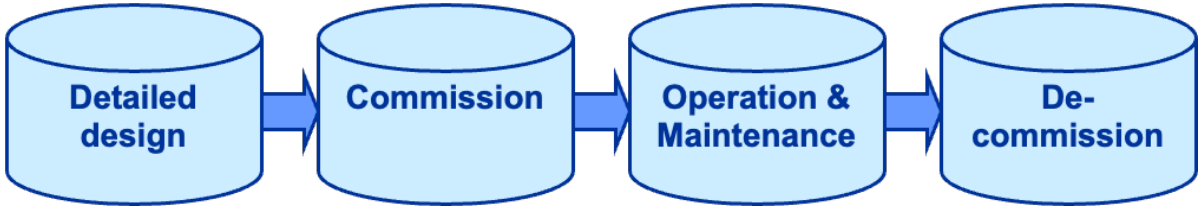
US Department of Energy (DoE)



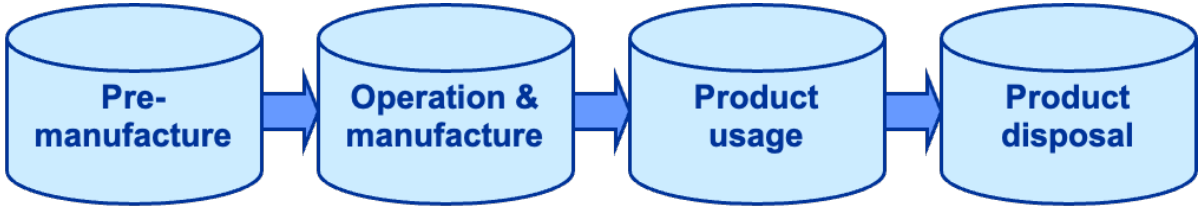
Different life cycles in business processes

- Project life cycles – drivers of change

- Asset life cycles – optimise operations in value chains



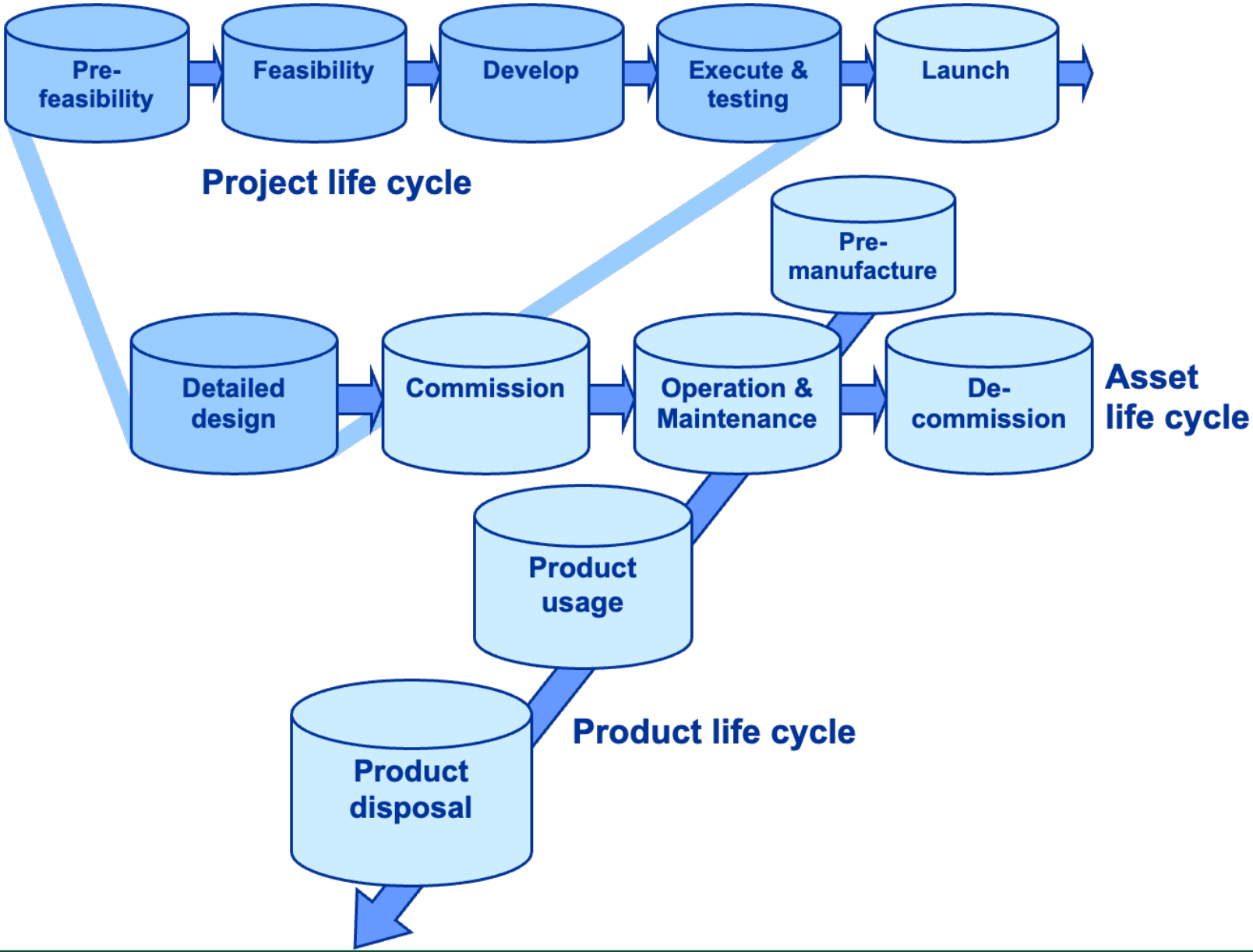
- Product life cycles – profit generation of operations



International Journal of Project Management
Volume 23, Issue 2, February 2005, Pages 159-168

Sustainable Project Life Cycle Management: the need to integrate life cycles in the manufacturing sector

Carin Labuschagne [a], Alan C. Brent [b]



Looking at examples

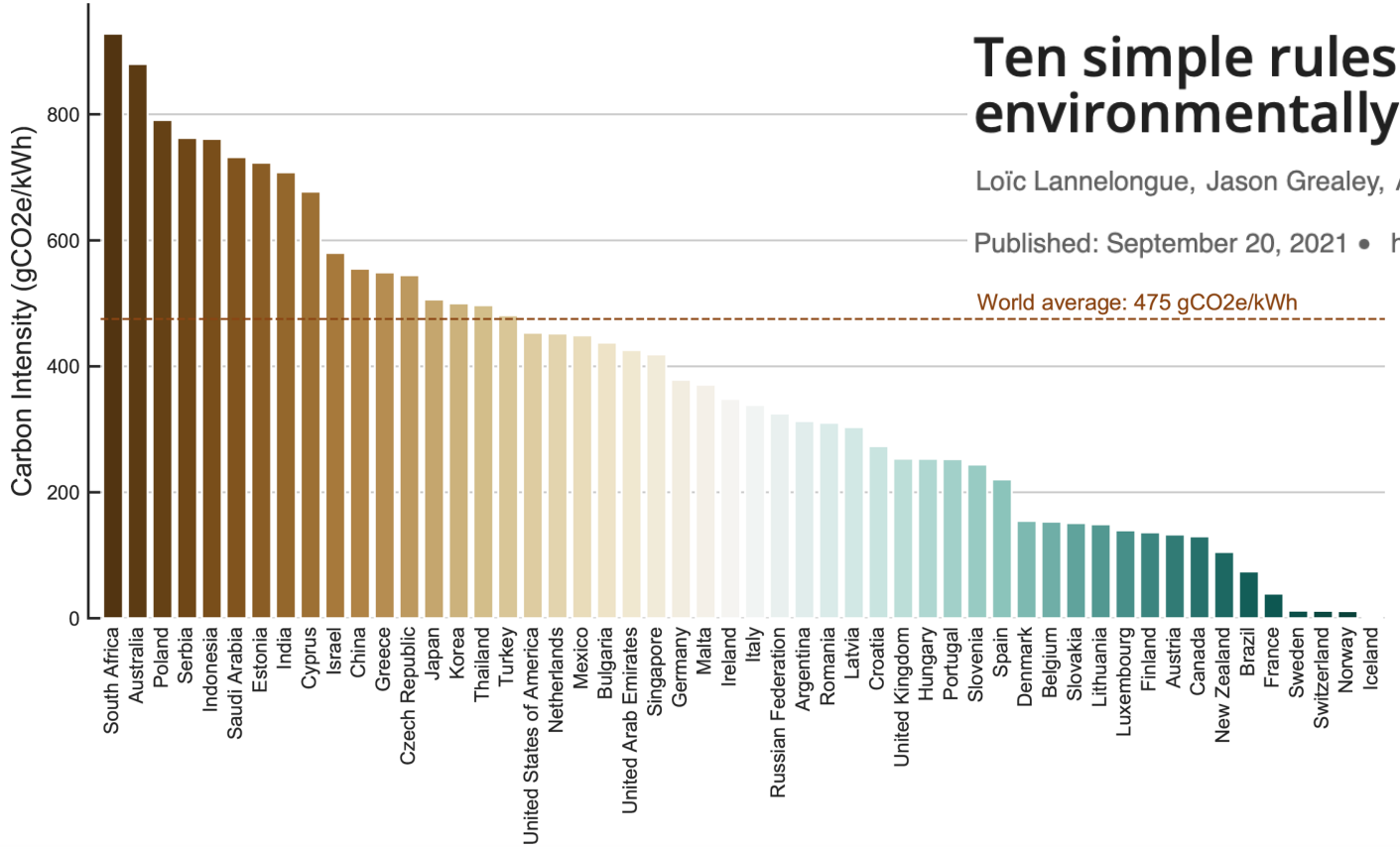
- https://www.planete-energies.com/en/media/photo-gallery/life-cycle-assessment-lca-cellphone

The case of coltan

- https://investingnews.com/daily/resource-investing/critical-metals-investing/tantalum-investing/coltan-facts/

The case of computing

- https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1009324



Ten simple rules to make your computing more environmentally sustainable

Loïc Lannelongue, Jason Grealey, Alex Bateman, Michael Inouye

Published: September 20, 2021 • https://doi.org/10.1371/journal.pcbi.1009324

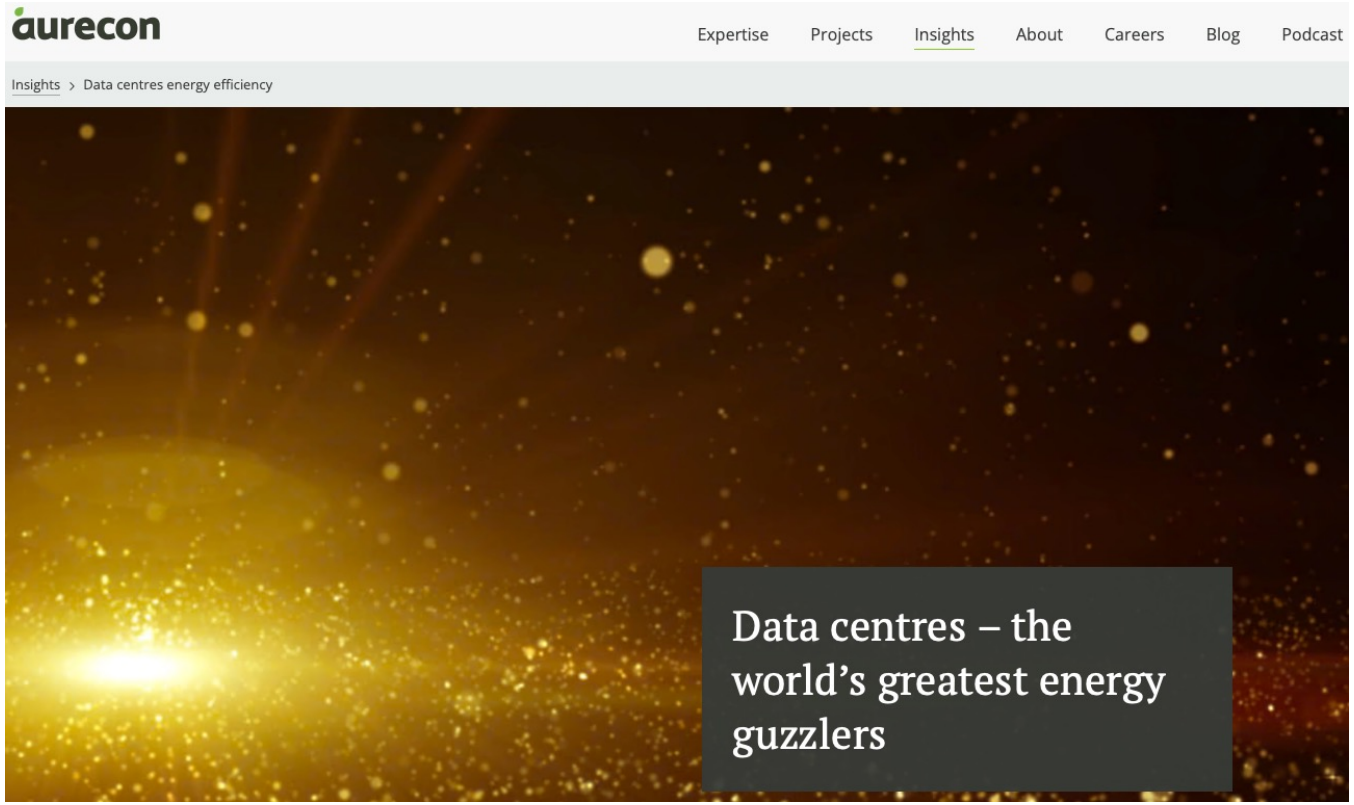
AI current in use / may be used in the future

- Should we be worried?
- What should we be worried about?

AI current in use / may be used in the future

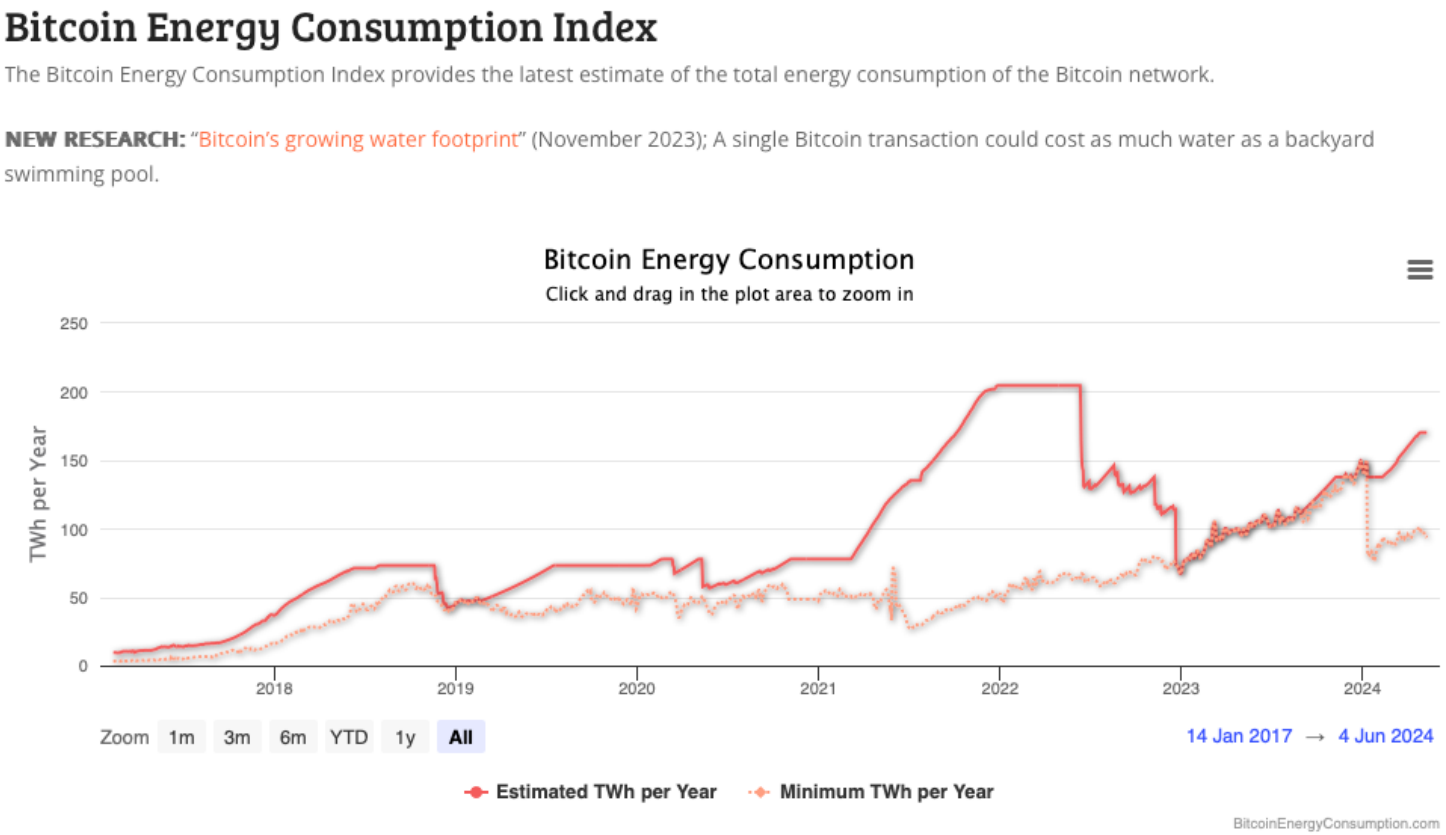
- Should we be worried?

- What should we be worried about?
  - About 10% of the world's energy
  - About 4% of Australia's total energy



Blockchain has similar issues

- https://digiconomist.net/bitcoin-energy-consumption



As does all social media platforms etc.

- https://carbonliteracy.com/the-carbon-cost-of-social-media

Platform	gCO2 per minute
YouTube	0.46
Twitch	0.55
Twitter	0.60
LinkedIn	0.71
Facebook	0.79
Snapchat	0.87
Instagram	1.05
Pinterest	1.30
Reddit	2.48
TikTok	2.63

Source: Greenspector

The Internet has become a huge challenge

- https://www.maddyness.com/uk/2020/03/09/the-internets-dirty-carbon-secret/

The internet's dirty carbon secret

We all know that using one-use products such as plastic bottles, coffee cups and plastic bags contribute to the release of greenhouse gases and have dire consequences on the environment but what do we know how our internet use is damaging our planet?

SHARE

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Although it's widely understood how electricity plays a huge role in the climate catastrophe, many are unaware of just how much their individual internet use contributes to this. Truth is, there is a huge amount of CO2 emissions generated through our internet use and the devices that we own are *constantly* on! Meaning that the CO2 emissions emitted from them never stop or have a break. A study by the Boston Consulting Group found that combining all of the world's smartphones, laptops, desktops and devices emits around one billion tonnes of greenhouse gases a year which works out as 2% of the world's total emissions.

The case of renewable energy

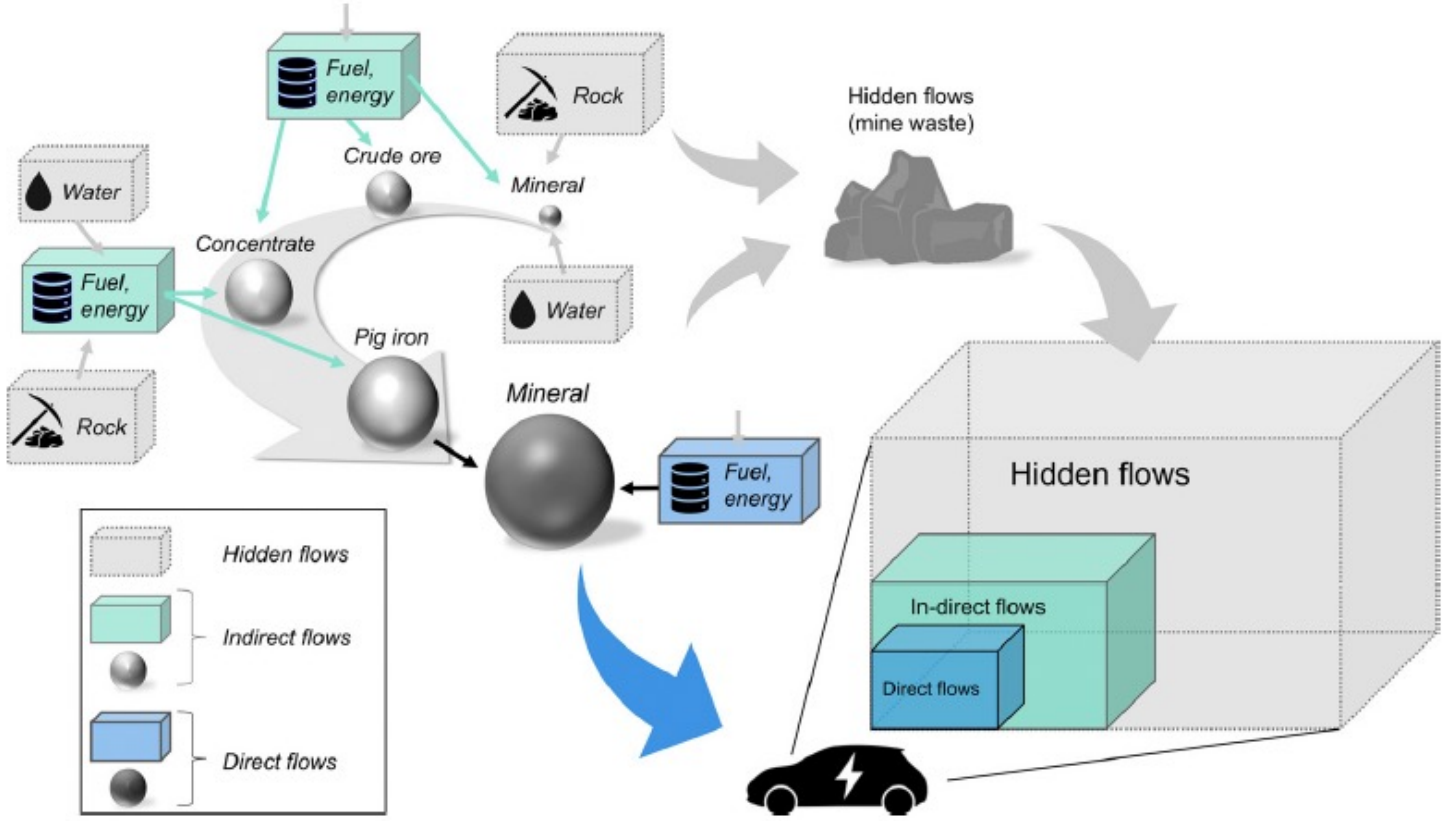
- https://www.mackinac.org/the-ethical-concerns-surrounding-solar-energy

There Are Ethical Concerns Surrounding Solar Energy

A growing human rights problem is being ignored

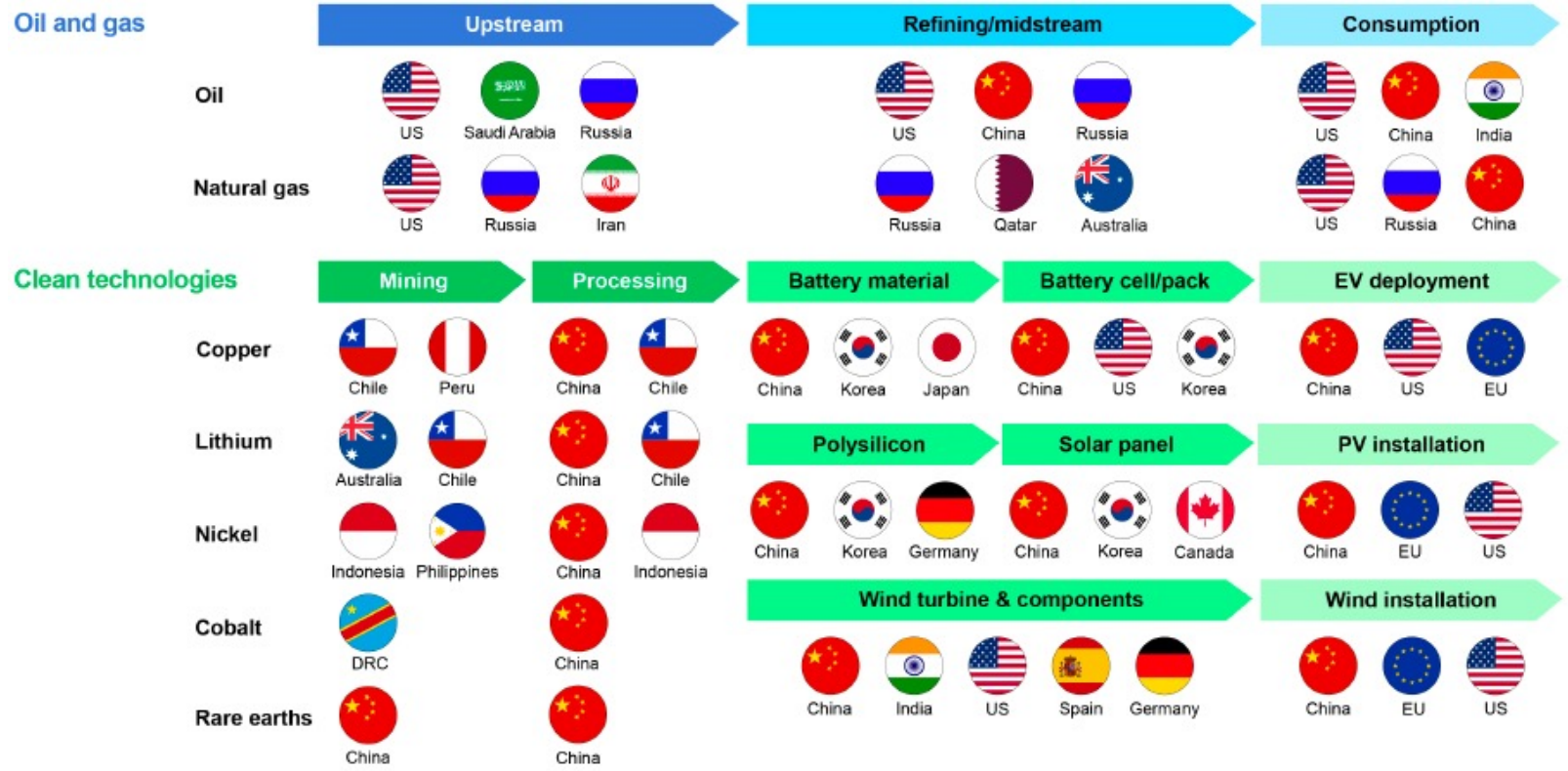
Upstream implications

- Watari et al., 2019. Total material requirement for the global energy transition to 2050.



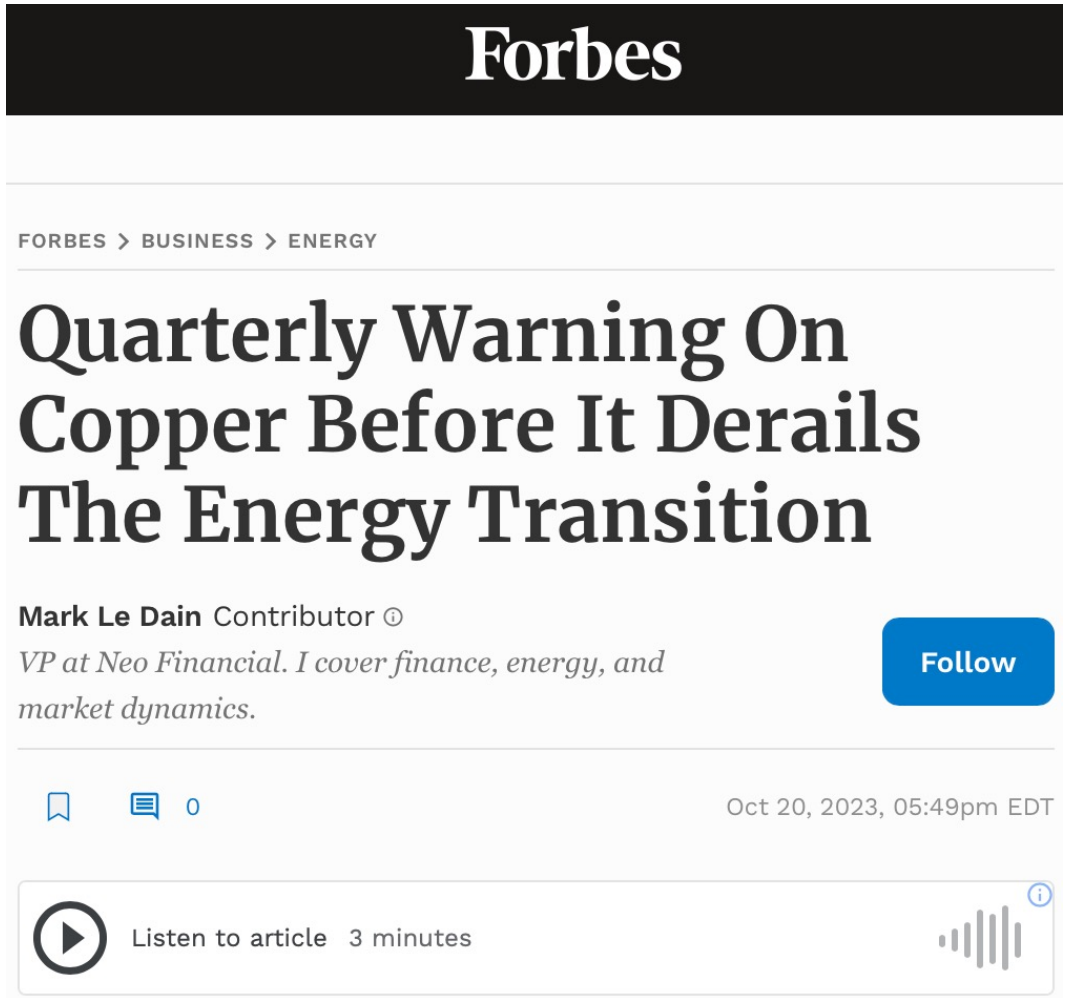
Shift in supply chains

- IEA, 2021. The role of critical minerals in clean energy transitions.



Mining implications

- “The world just doesn’t get it. It doesn’t understand that a massive copper deficit is coming”
- “The world will stop without the additional copper supply. But the price of copper is not expecting it.”
  - Glencore CEO Gary Nagle.



Forbes

FORBES > BUSINESS > ENERGY

Quarterly Warning On Copper Before It Derails The Energy Transition

Mark Le Dain Contributor

VP at Neo Financial. I cover finance, energy, and market dynamics.

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Oct 20, 2023, 05:49pm EDT

Listen to article 3 minutes

Mining implications

- https://www.popularmechanics.com/science/environment/a44630329/deep-sea-mining/

Science > Our Planet

Deep-Sea Mining Could Yield a Nearly Limitless Supply of Rare Metals. Is It Worth the Cost?

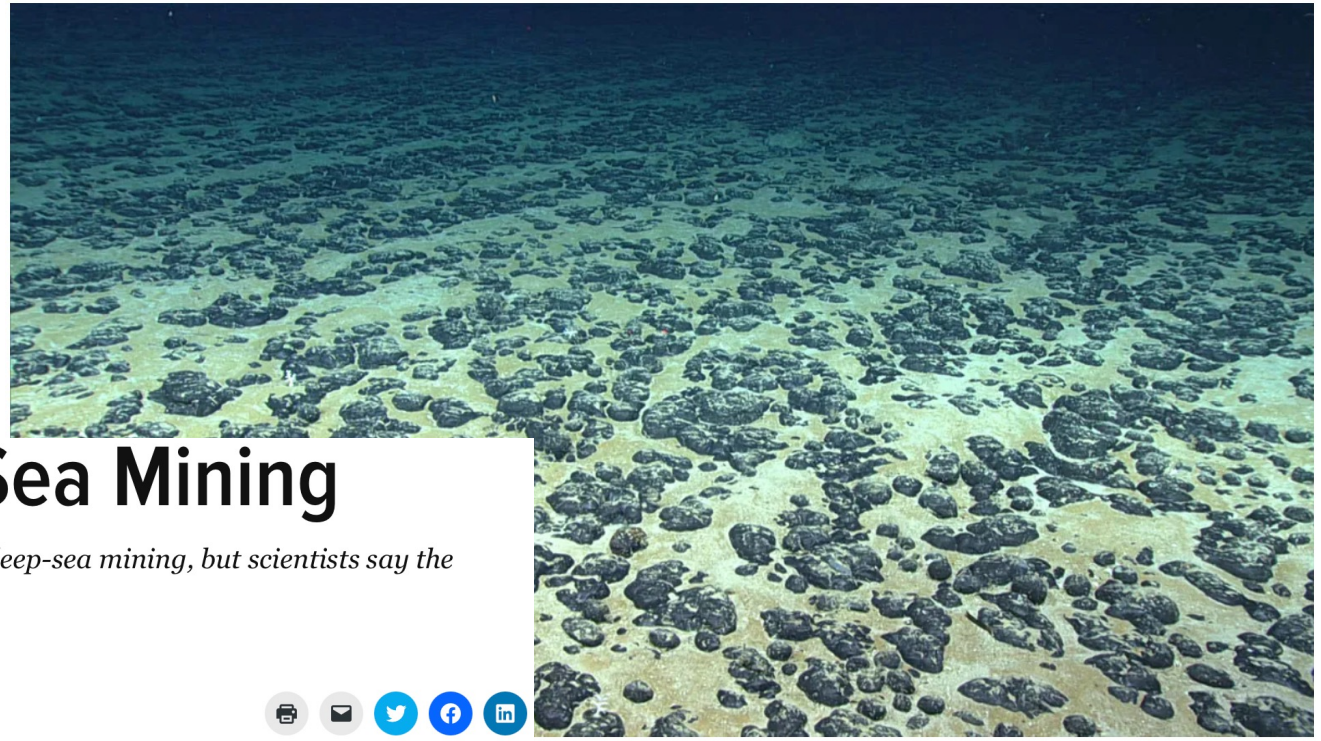
New regulations for drilling into the seabed could come any day now, following two years of infighting between an international regulatory body, drilling companies, and scientists.

BY SUSAN LAHEY PUBLISHED: JUL 24, 2023

Mining implications

- https://eos.org/features/the-2-year-countdown-to-deep-sea-mining

- Clarion-Clipperton Zone (CCZ)
  - 5,000 kilometre stretch of seafloor
  - 4,000 to 5,500 metres deep



The 2-Year Countdown to Deep-Sea Mining

A small island nation is forcing the hand of international regulators to finalize rules for deep-sea mining, but scientists say the environmental consequences are not yet clear.

By **Jenessa Duncombe** 24 January 2022

Black, potato-sized polymetallic nodules scattered on the seafloor are drawing prospectors for their cobalt, nickel, copper, and manganese. Credit: 2019 Southeastern U.S. Deep-sea Exploration/Office of Ocean Exploration and Research/NOAA

Required interventions

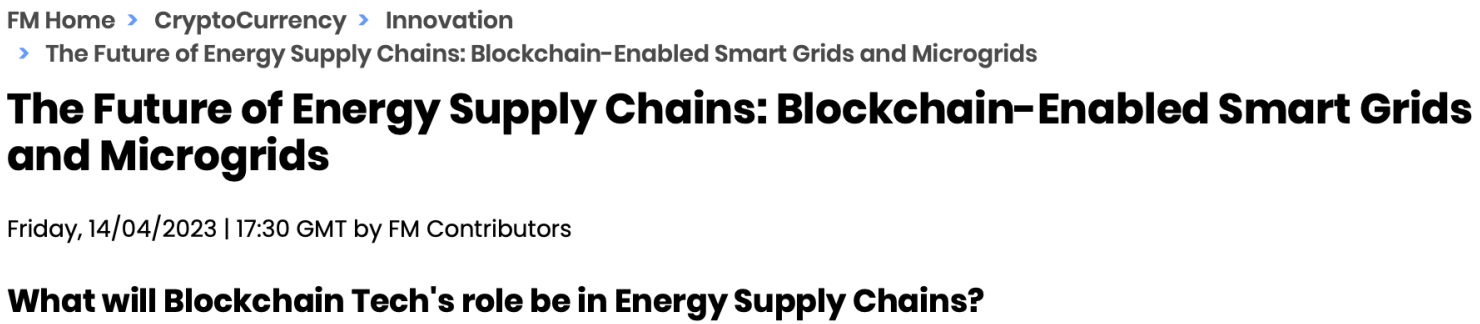
- https://www.linkedin.com/pulse/complexities-clean-energy-demand-how-supply-chain-transparency/

Complexities of clean energy demand and how supply chain transparency responds to potential barriers

Greater transparency on projects, the materials they source, their domestic content, and continuous monitoring of their impacts on local environments and communities can unlock investments and regulatory approvals. A virtuous cycle can form, in which more responsibly and sustainably produced clean energy is powering more clean energy manufacturing and clean energy capacity with unquestionable proof of an overall positive impact. An unambiguous license to operate through traceability, coupled with investment and policy, can remove obstacles to fully unleash the energy transition and ensure it delivers on its promises.

Required interventions

- https://www.financemagnates.com/cryptocurrency/innovation/the-future-of-energy-supply-chains-blockchain-enabled-smart-grids-and-microgrids/#



FM Home › CryptoCurrency › Innovation
› The Future of Energy Supply Chains: Blockchain-Enabled Smart Grids and Microgrids

The Future of Energy Supply Chains: Blockchain-Enabled Smart Grids and Microgrids

Friday, 14/04/2023 | 17:30 GMT by FM Contributors

What will Blockchain Tech's role be in Energy Supply Chains?

  - Scalability
  - High energy consumption
  - Regulatory challenges
  - Interoperability
  - Cybersecurity risks
  - Human element

Downstream implications

- https://www.sydney.edu.au/news-opinion/news/2023/09/13/australia-faces-solar-waste-crisis.html

Australia faces solar waste crisis

13 September 2023

Research addresses the legal gap

Australia is world leading in its uptake of residential rooftop solar, installing new solar panels at ten times the global average rate. This means, on a per capita basis, the solar waste problem facing Australia is far greater than that experienced in any other country. New research from the Sydney Law School aims to re-orientate renewable energy laws.

Australia is now facing a solar waste crisis.

The International Renewable Energy Agency, the International Energy Agency and the Australian Government have all identified the issue of solar waste. In her June 2021 National Press Club address the (now previous) federal Environment Minister Sussan Ley described the problem

Sydney Law School Research

Discover

Sally Quinn

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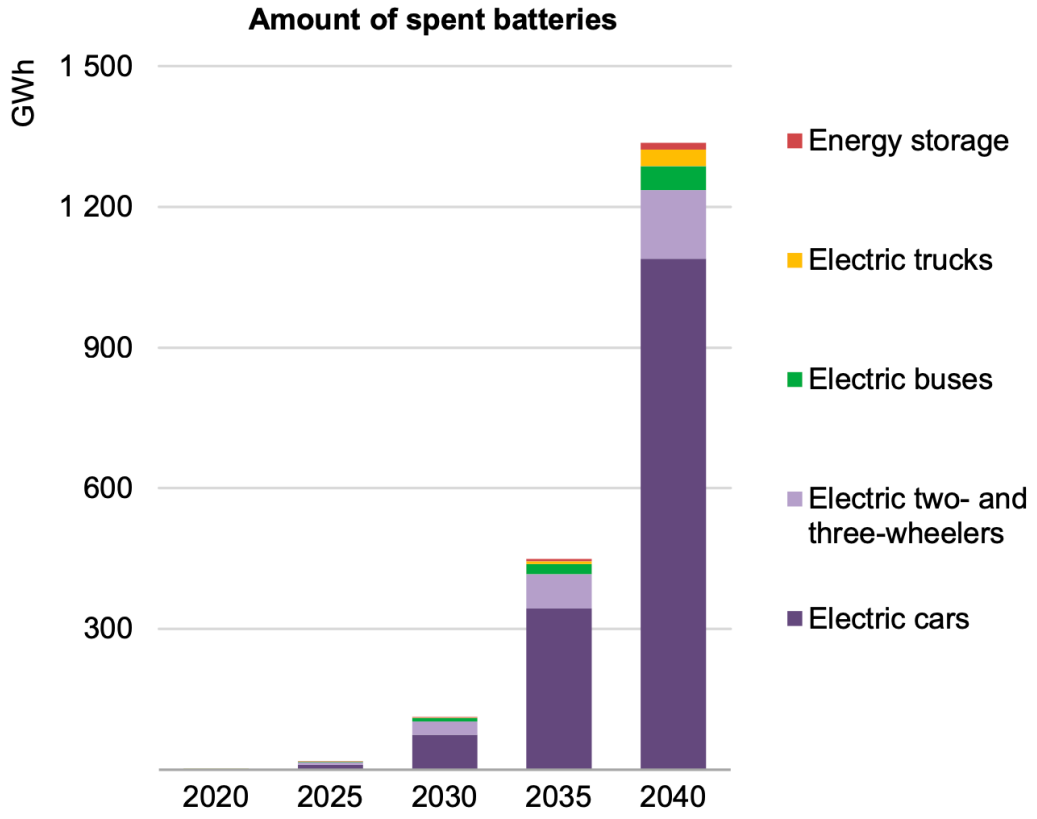
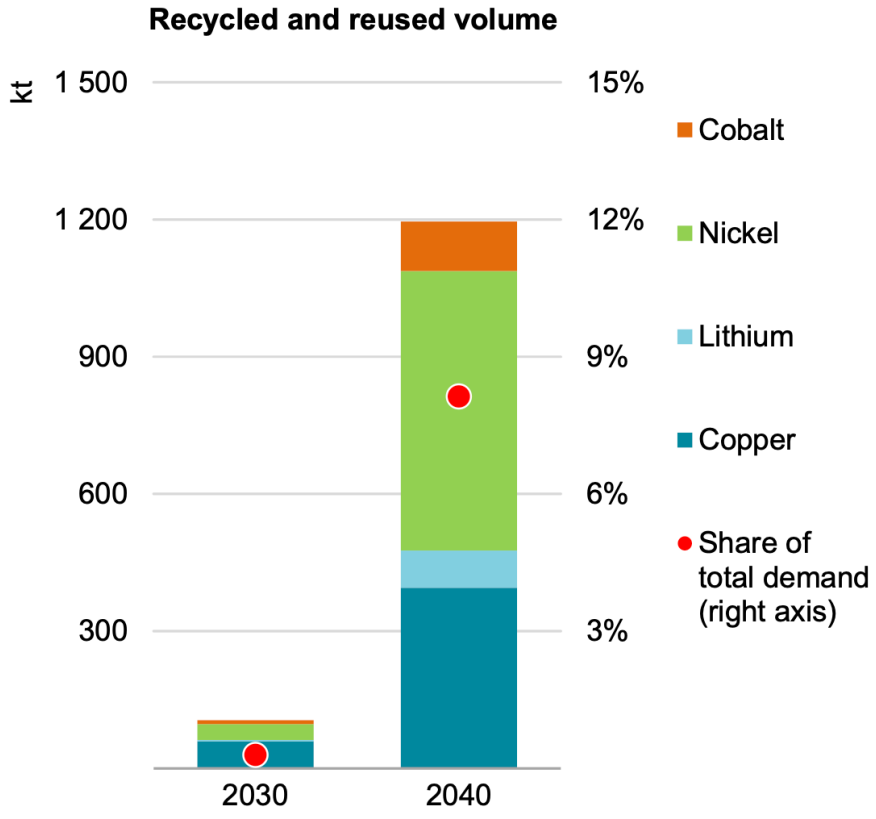
Downstream implications

- IEA, 2021. The role of critical minerals in clean energy transitions.



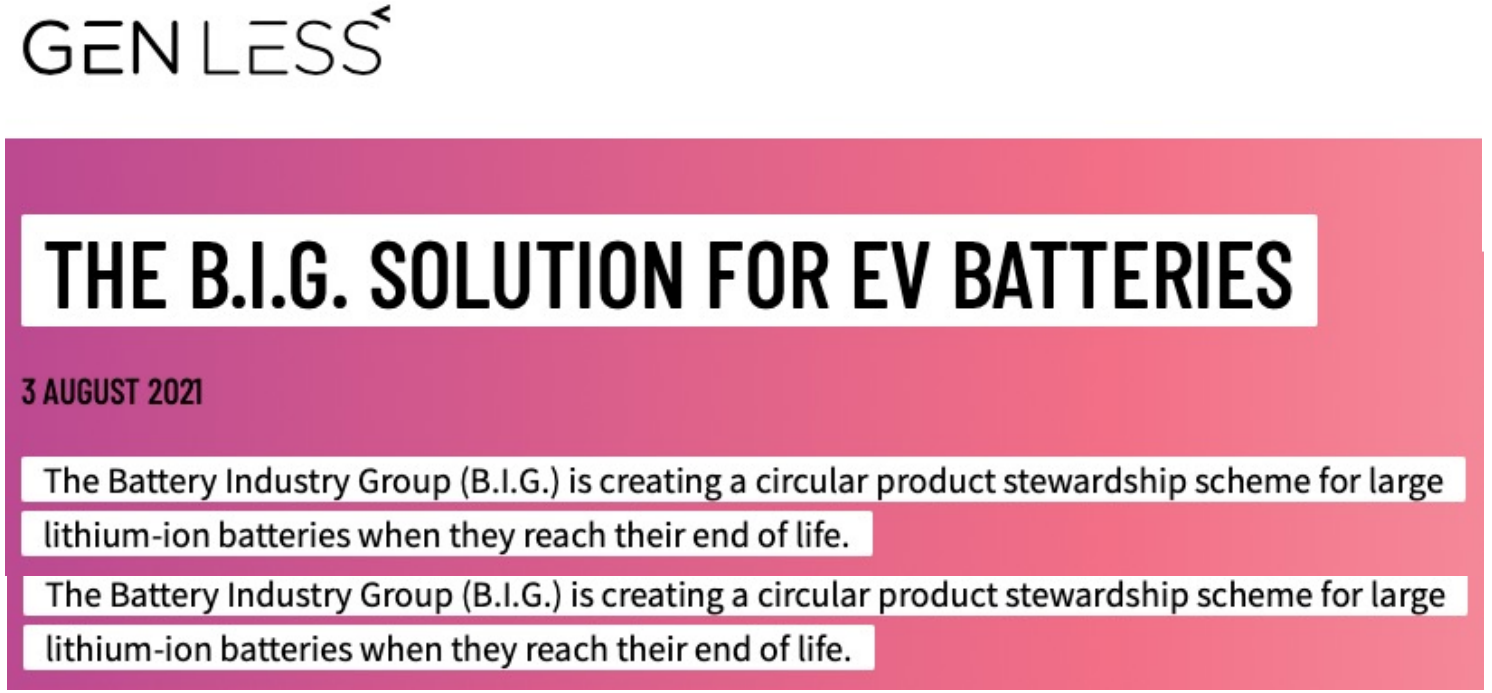


Global E-waste Monitor 2020

- https://ewastemonitor.info/gem-2020/

End-of-life interventions

- Distinct aspect of circular economy strategies are being analysed
  - Not comprehensive to the clean energy transition
- Recycling will be crucial for future resource availability
  - A long-term strategy
  - Connected economies needed



Life-cycle thinking approach

- https://lcanz.org.nz/lca-guidance/lca-intro/

LCANZ
Life Cycle Association of New Zealand