

Shifting Sands: The circular economy and its implications for the resources sector

An Australian perspective from

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CSIRO ENERGY AND RESOURCES
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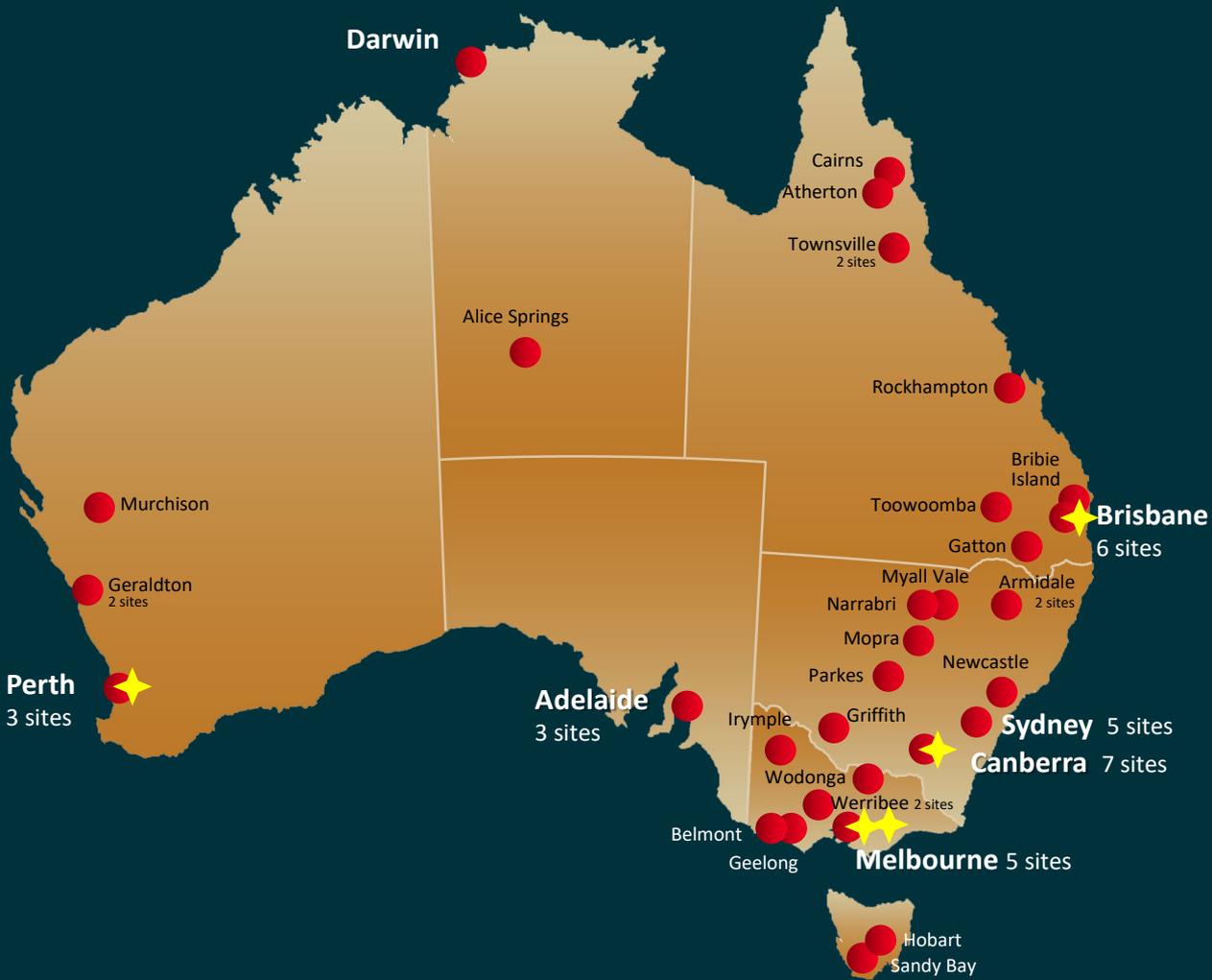
People 6035

Sites 55

Budget \$1B+

64% of our people hold university degrees over 2000 hold doctorates over 500 hold masters

We develop 832 postgraduate research students with our university partners



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AGRICULTURE



LAND AND WATER



OCEANS AND ATMOSPHERE



ENERGY



MINERAL RESOURCES



MANUFACTURING



FOOD AND NUTRITION



DIGITAL PRODUCTIVITY AND SERVICES



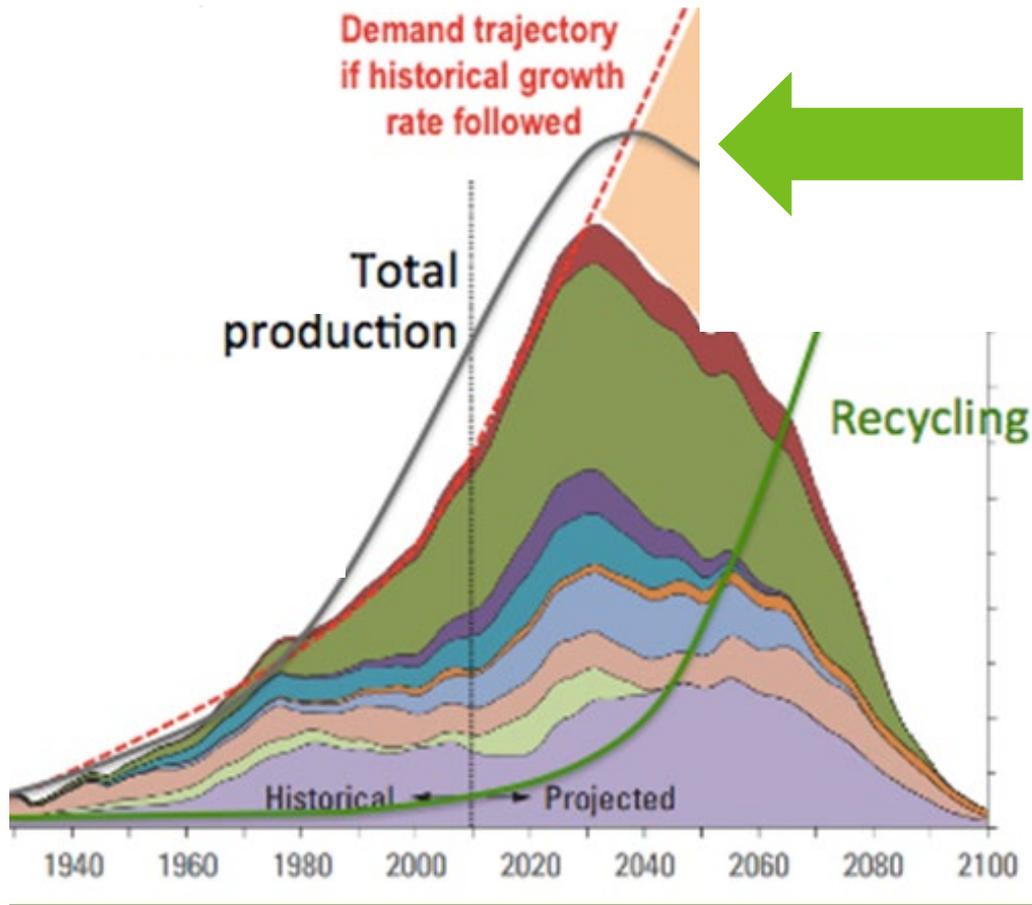
BIOSECURITY

Resource Supply and Demand – dig, ship and smelt



Historical and projected primary copper production

Modified from Kerr 2014 and Northey et al 2014
with input from recycling from O Vidal (unpub)

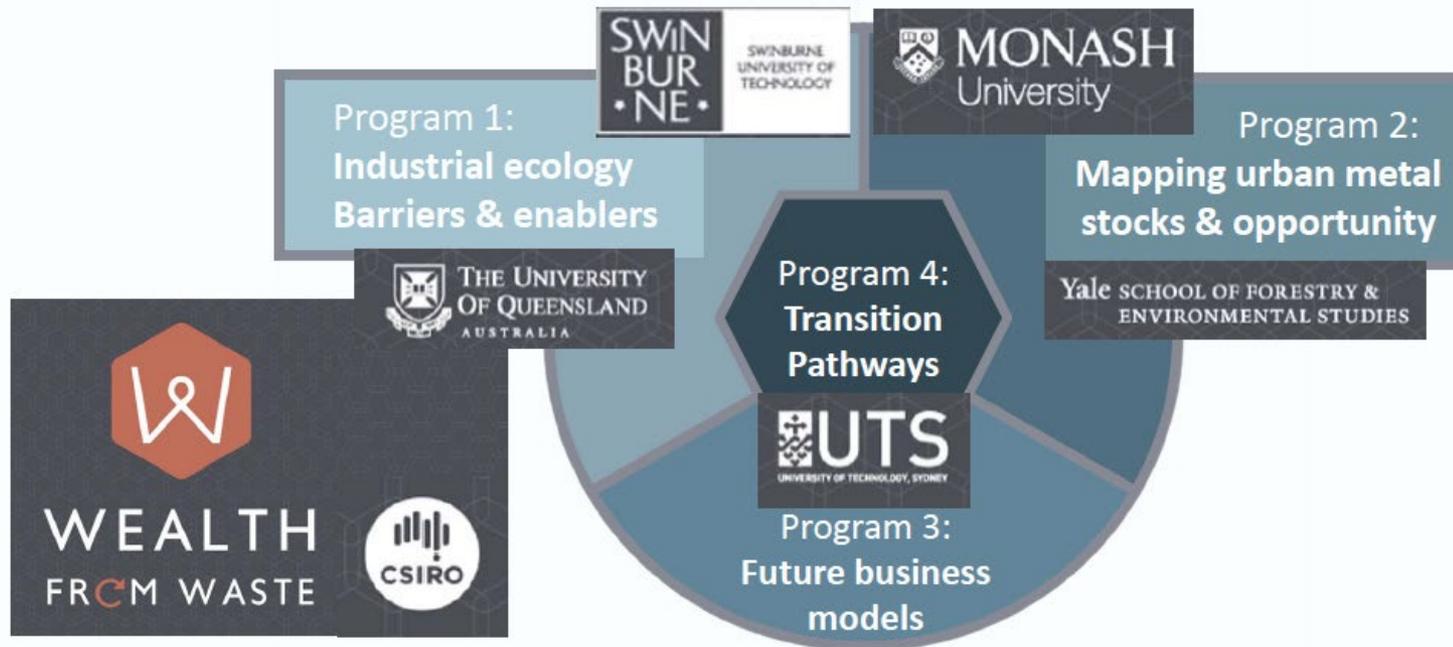


Today's known reserves leave a 30Mt shortfall in 2050 in available supply from primary resources to meet the world's historical demand trajectory.

Resource productivity – towards a circular economy

WEALTH FROM WASTE CLUSTER

2013-2017



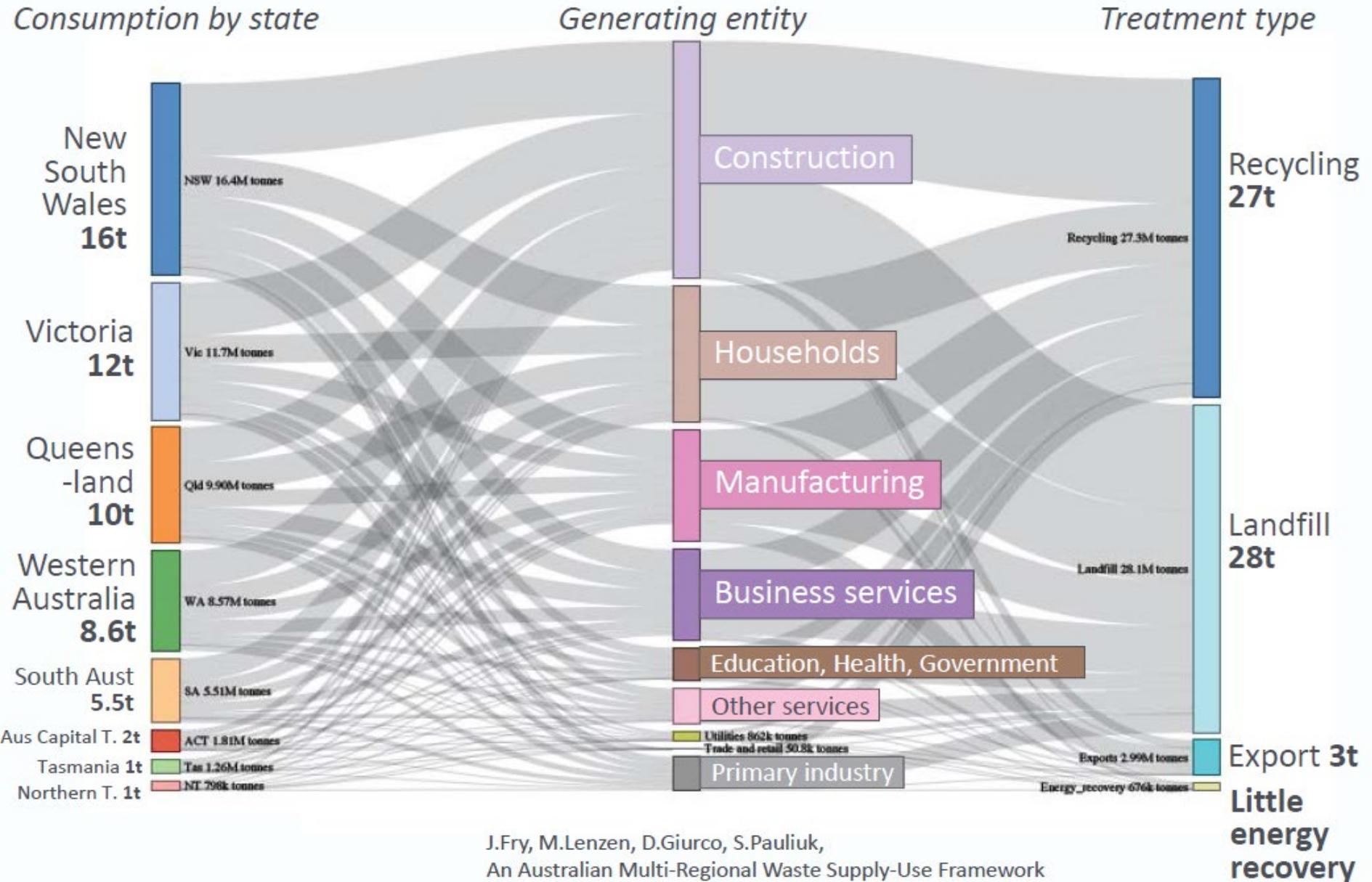
Advancing transition pathways towards the circular economy for metals



CLUSTER REFERENCE PANEL & COLLABORATORS

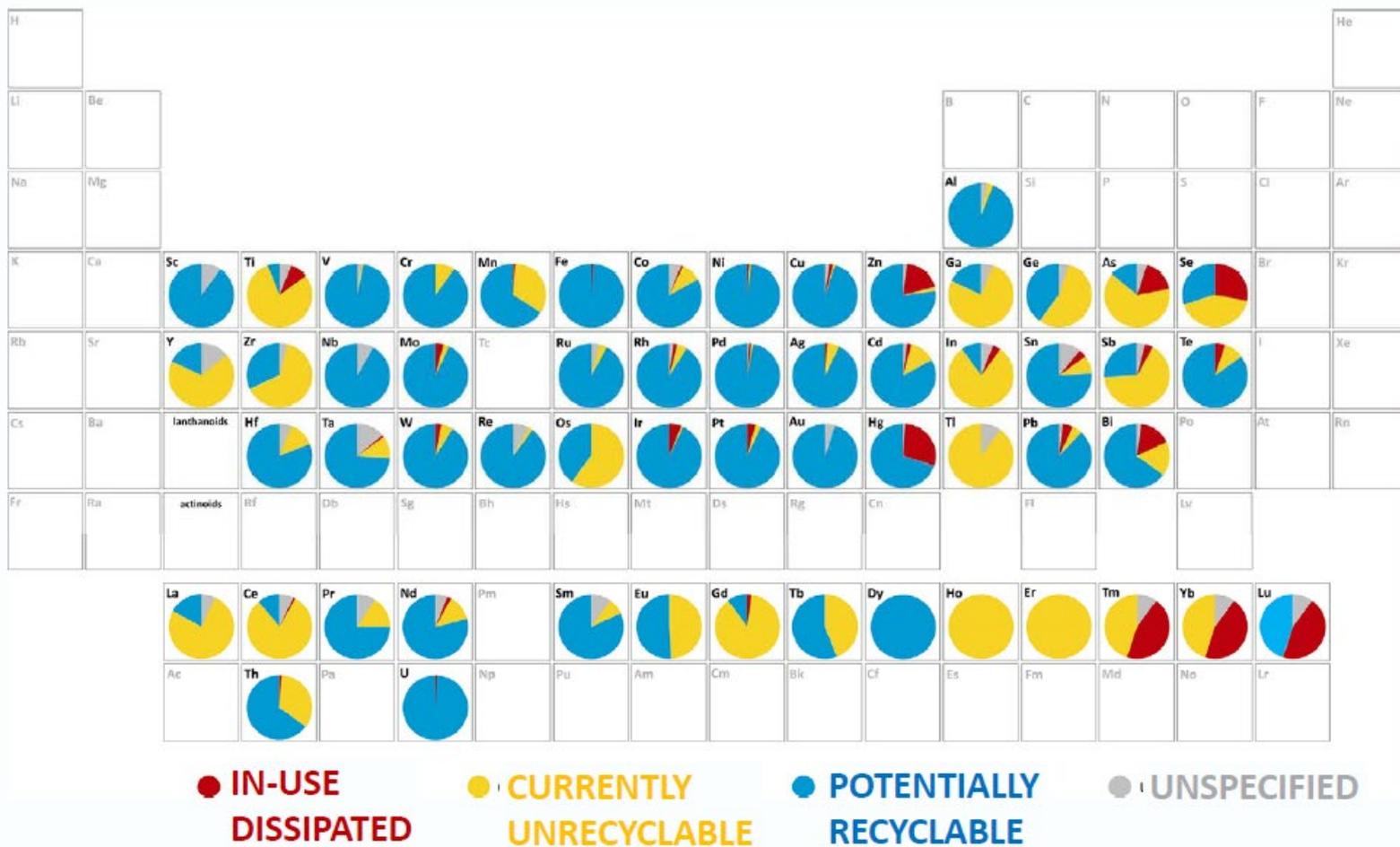


WASTE FLOWS IN AUSTRALIA



J.Fry, M.Lenzen, D.Giurco, S.Pauliuk,
 An Australian Multi-Regional Waste Supply-Use Framework
Journal of Ind. Ecology (in press)

ELEMENTS LOST BY DESIGN



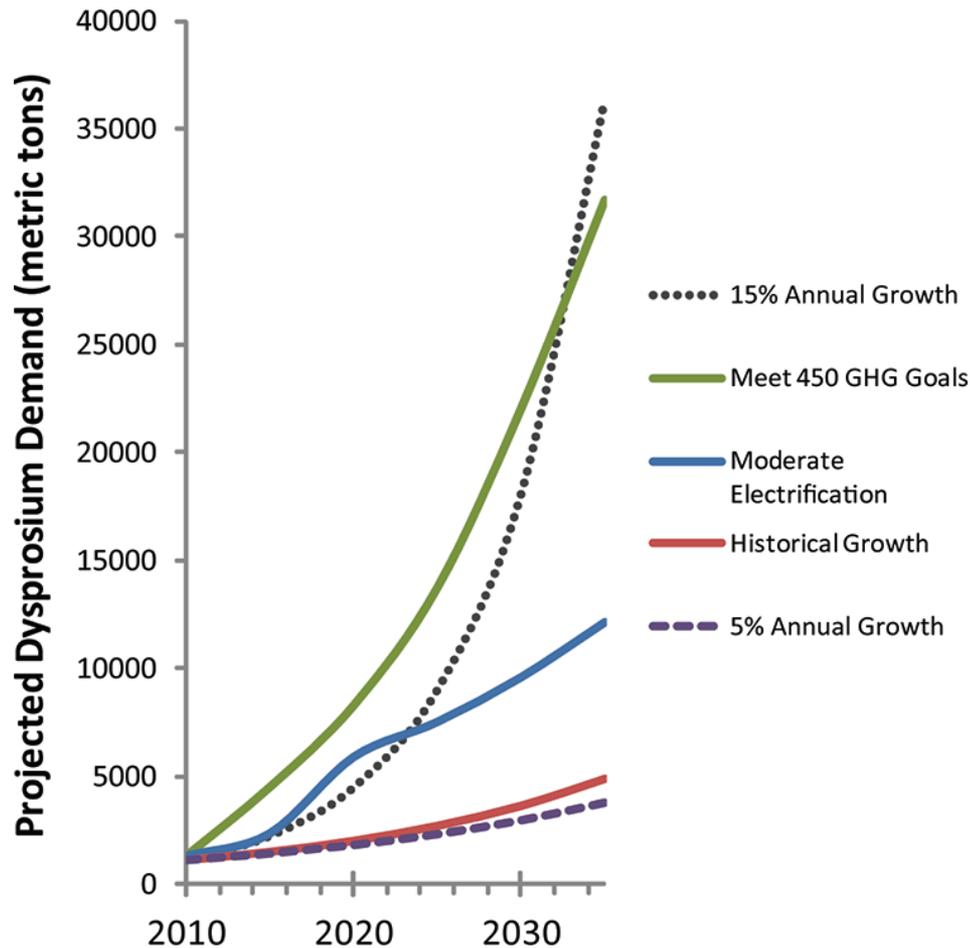
Published in: Luca Ciacci; Barbara K. Reck; N. T. Nassar; T. E. Graedel; *Environ. Sci. Technol.* **2015**, 49, 9443-9451.

DOI: 10.1021/es505515z

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Changing demand as technology develops – the rare earth conundrum



Alonso et al. » Evaluating Rare Earth Element Availability: A Case with Revolutionary Demand from Clean Technologies.”
Environ. Sci. Technol. 2012, 46, 3406–3414



FUTURE BUSINESS MODELS

D Giurco, D van Beers, S. Sharpe, B. Madden, N. Florin, E. Dominish, F. Grossi, M. Kuhndt - UNPUBLISHED-

Opportunities and challenges for the circular economy in Australia: the role of innovative business models, unpublished for submission to AJEM

as per Geels et al 2015

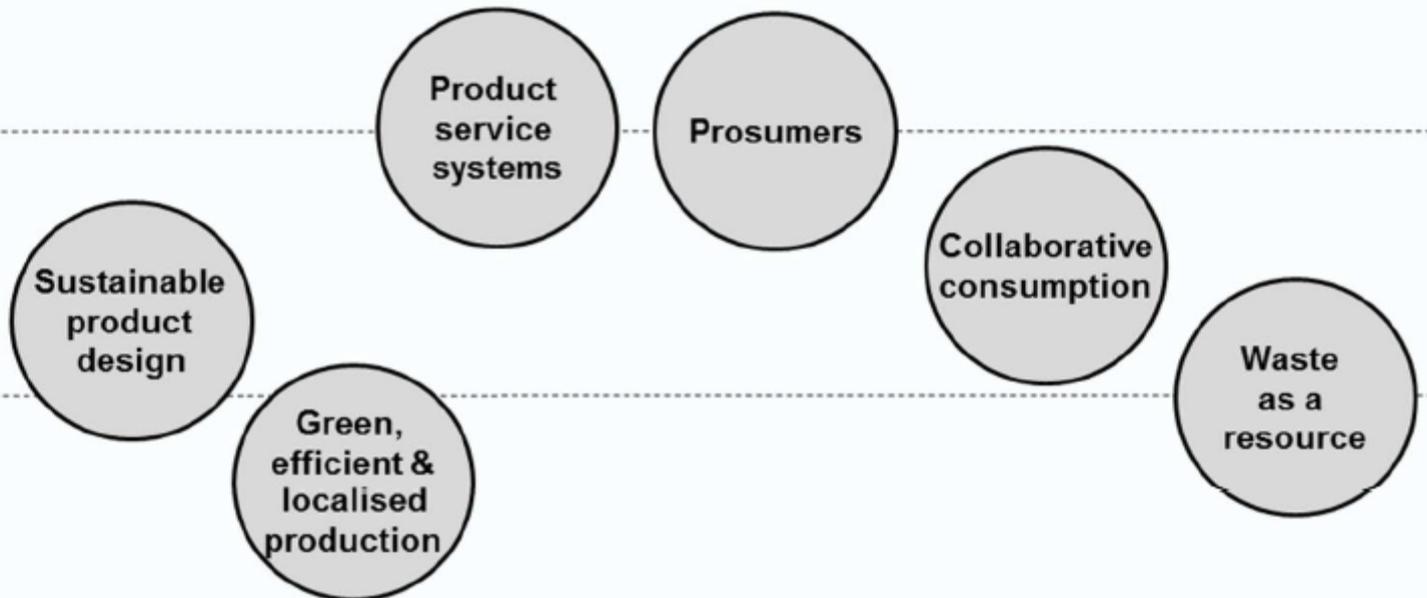
Type of change

Applicable to both profit and non-profit organisations.
Applicable to both business-to-consumer (B2C) and business-to-business (B2B)

(3) Revolution:
Re-invent and new systems

(2) Reconfiguration:
Transformative change

(1) Reformation:
Optimise existing systems



Production

Use

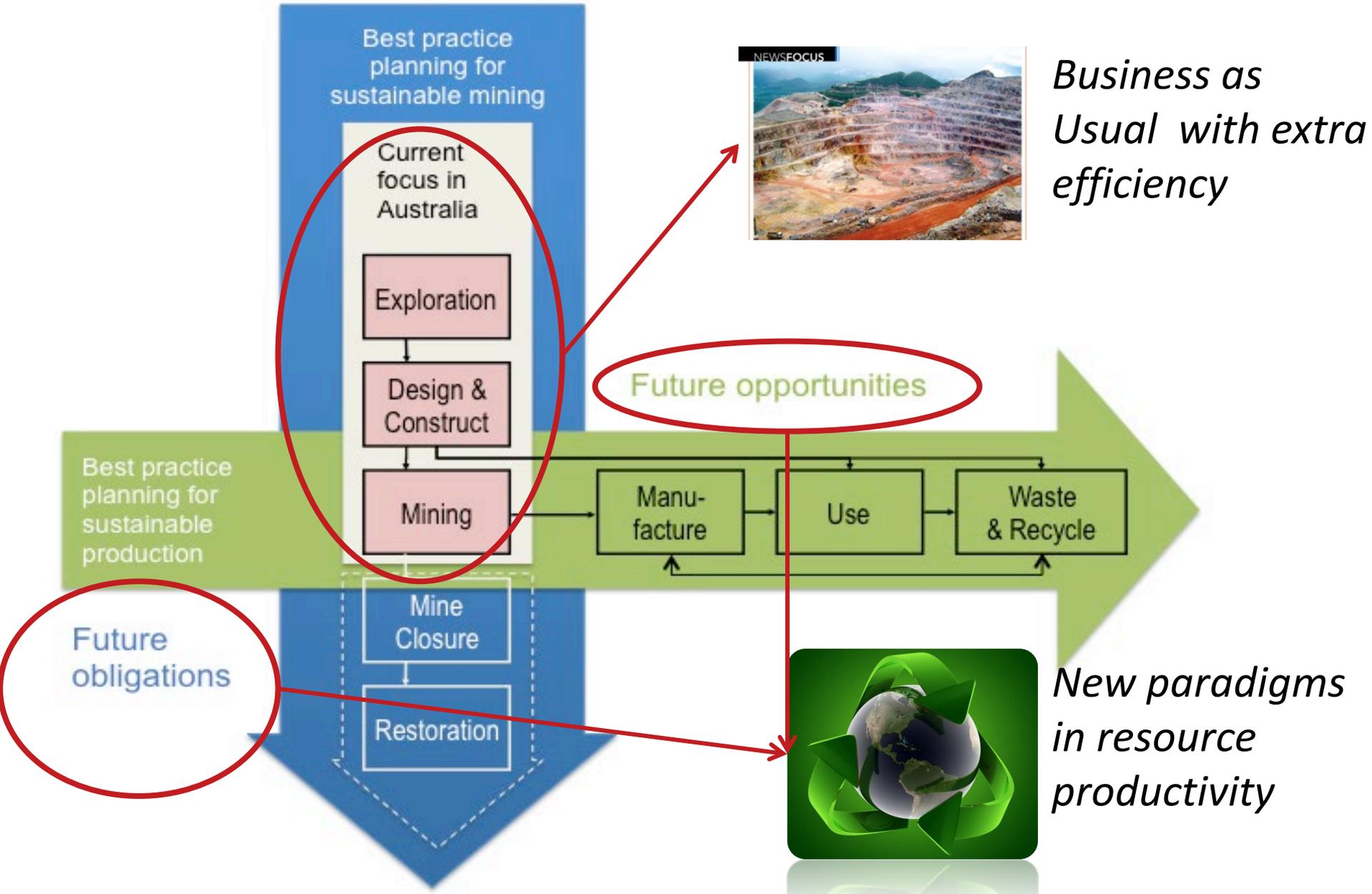
End-of-life

Key focus of efforts in value chain

The role of technology and innovation

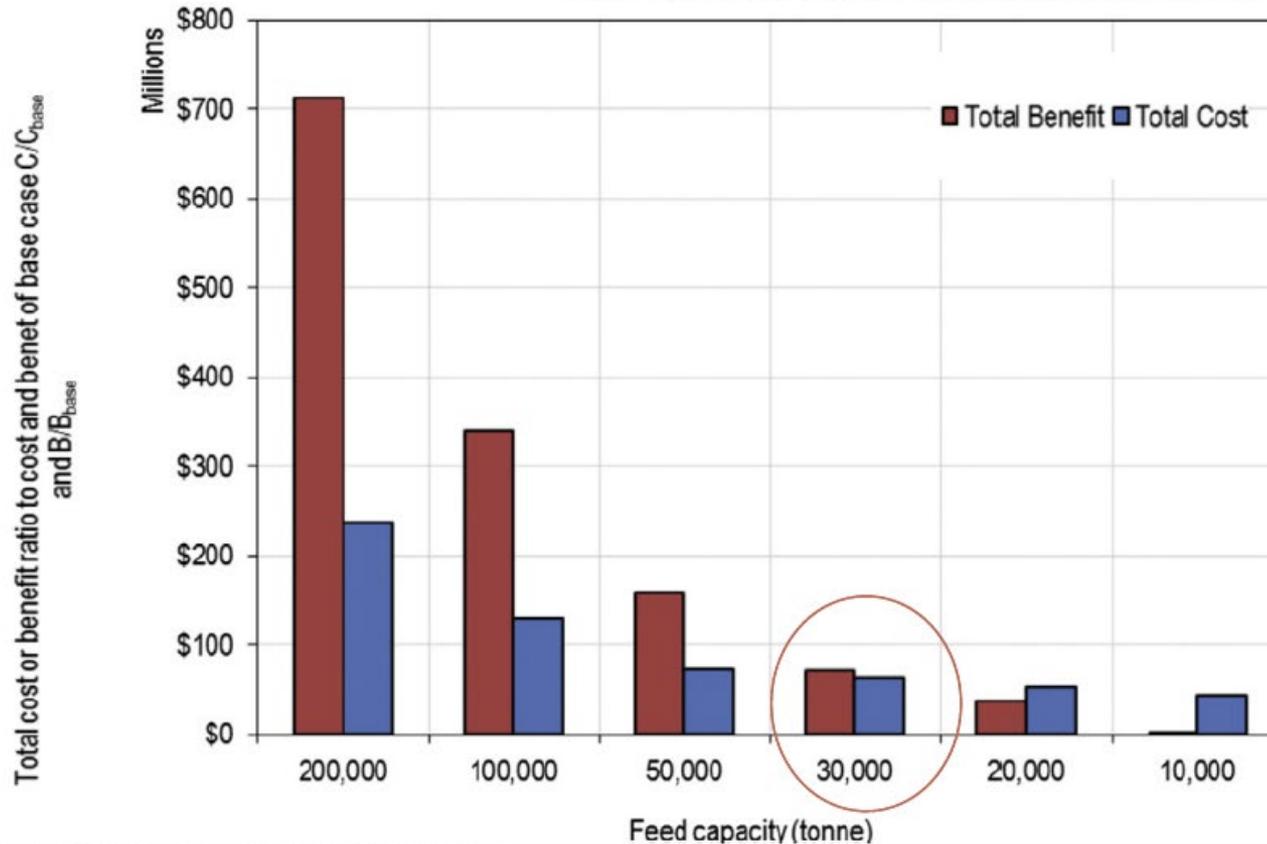
Towards a circular economy – the role of innovation

Photo: David Monniaux



E-WASTE RECYCLING VIA BLACK COPPER ROUTE: EFFECT OF SCALE

A/Prof Akbar Rhamdhani, Swinburne University



Techno economic analysis of electronic waste processing through black copper smelting route

Maryam Ghodrati^{a,b,*}, M. Akbar Rhamdhani^{a,b}, Geoffrey Brooks^{a,b}, Syed Masood^{a,b}, Glen Corder^{b,c}

Journal of Cleaner Production 2016

High-Value Chemical Manufacturing

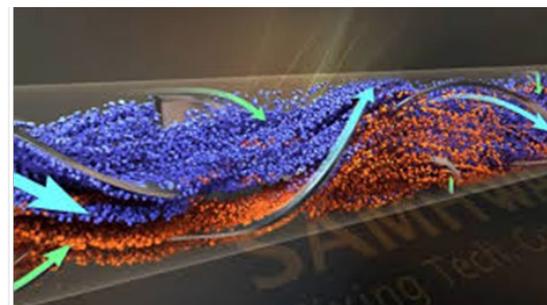
Establishing a competitive Australian high-value chemical manufacturing industry integrated with global supply-chains and markets

CSIRO has highly developed core competencies in the discovery and optimisation of chemical reactions; scale-up to pilot/production scale and tailored tech transfer packages for clients.

Key Focus: Process Intensification and Continuous Flow Chemistry Processing.

CSIRO develops better chemical processes with (that):

- Higher yields
- Fewer by-products
- Less waste
- Shorter processing times
- Safer
- Lower build-cost



Energy from Waste

Enabling a waste to energy industry in Australia

Urban waste streams

- MSW, green waste, biosolids

Agricultural residues

- Bagasse, cotton gin trash

Industry wastes and by-products

- e.g. timber industry
- Autothermal pyrolysis



Research

- Understanding waste conversion technologies; matching technologies to waste types
- Fuel preparation and handling requirements
- Demonstration of waste gasification processes, and integration with catalytic systems

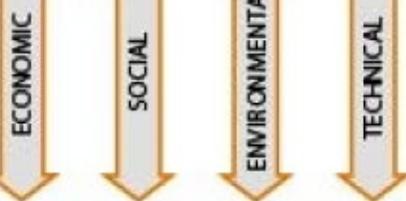
Summary

- 1. WfW has broadened industry, research and policy focus on resources to include both above and below ground stocks**
- 2. Technological innovations can lead to new business models – new approaches to smelting, solar powered, mini-scale....for example on a ship docking to process e-waste at islands across the pacific.**
- 3. Design for renewable energy and resource cycles - the renewable energy revolution is coming, requiring new combinations of metals**
- 4. Systems for cycling resources must be flexible to changing product composition**
- 5: Australia is not yet ready to sacrifice first-life efficiency through reduced complexity to facilitate 'second-life' pathways.**

CHARTING A PATHWAY FOR TRANSITION

DRIVERS OF CHANGE

2015



BUSINESS-AS-USUAL

LINEAR ECONOMY where the value of resources are lost in the economy

INCONSISTENT POLICIES between different levels and jurisdictions of government

DECLINING PRODUCTIVITY

TRADE-EXPOSED ECONOMY dependent on natural resource exports

MARKET FAILURE to internalise environmental and social impacts of resource use

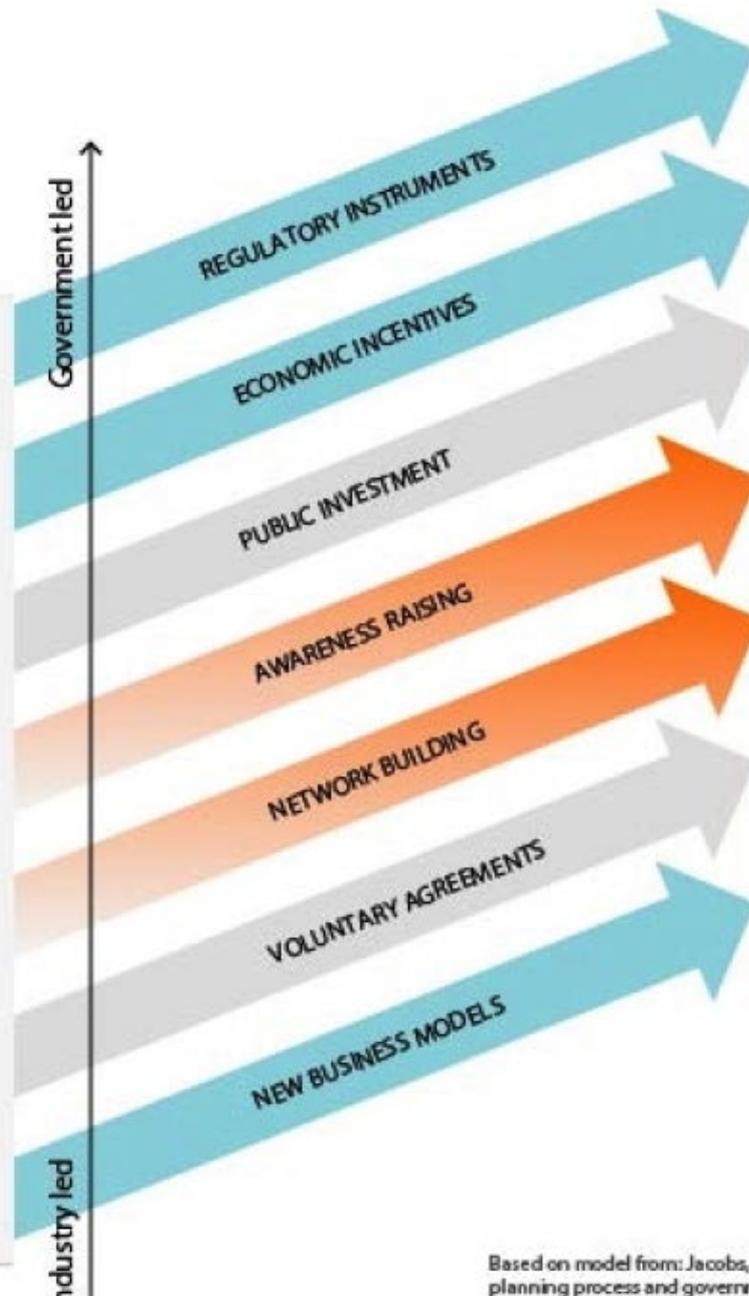
POOR RECORD OF COLLABORATION between industry, government and academia

LIMITED RECYCLING and increasing waste to landfill

DECLINING ENVIRONMENTAL HEALTH

Government led

Industry led



TRANSFORMED SYSTEM CIRCULAR ECONOMY

VALUE OF RESOURCES REFRAMED that leads to economic, social and environmental benefits

OPTIMISED RESOURCE PRODUCTIVITY through the economy

NEW MODES OF CONSUMPTION that promote sufficiency

RESTORATION OF SOCIAL AND NATURAL CAPITAL

POWERED BY RENEWABLE ENERGY across the supply chain

SYSTEM WIDE INTEGRATION for scaling up from individual firms and sectors to collaboration across the supply chain (from resource extraction to waste management and consumers)

GOVERNANCE STRUCTURES supporting long term thinking

Concluding Comments

