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

*An Australian perspective from*

**Kathie McGregor, Mark Cooksey, Damien Giurco and Anna Littleboy**

**CSIRO ENERGY AND RESOURCES**
www.csiro.au

# CSIRO and Resources

| | |
|---|---|
| **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

# We explore how the world works through our Research Businesses

AGRICULTURE

LAND AND WATER

OCEANS AND ATMOSPHERE

ENERGY

MINERAL RESOURCES

MANUFACTURING

FOOD AND NUTRITION

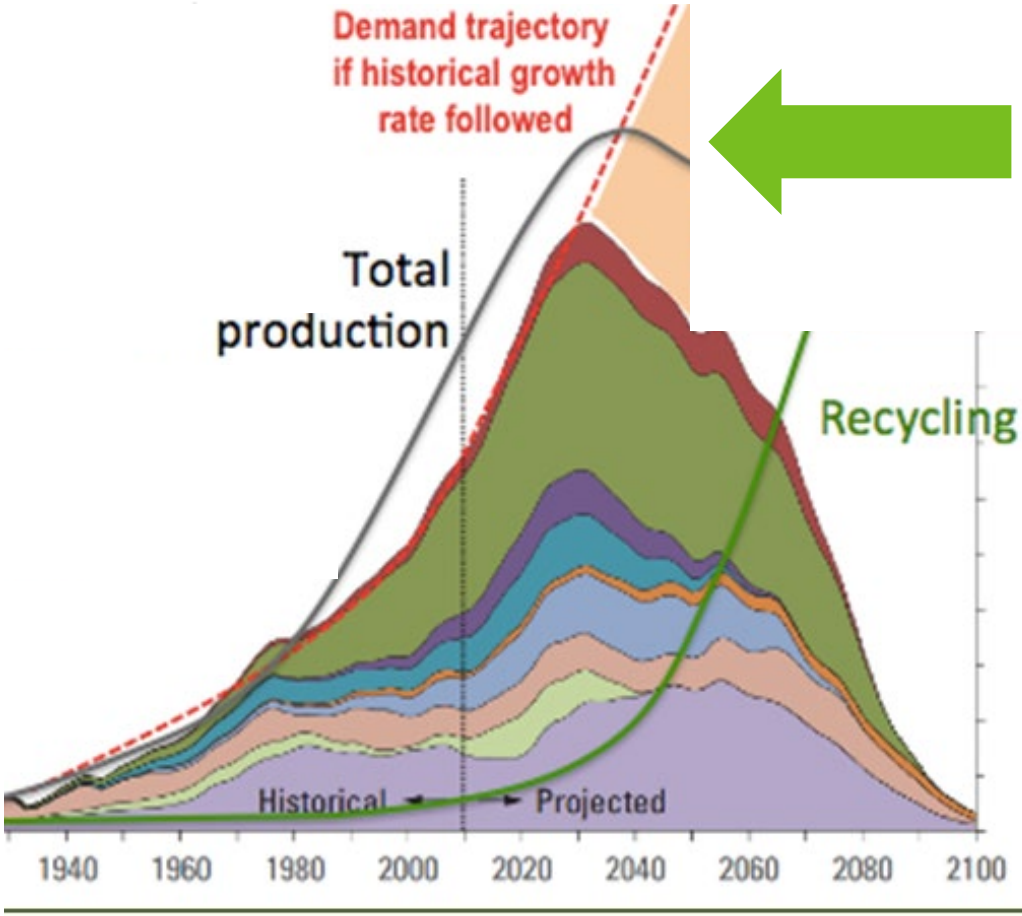
DIGITAL PRODUCTIVITY AND SERVICES

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 form O Vidal (unpub)

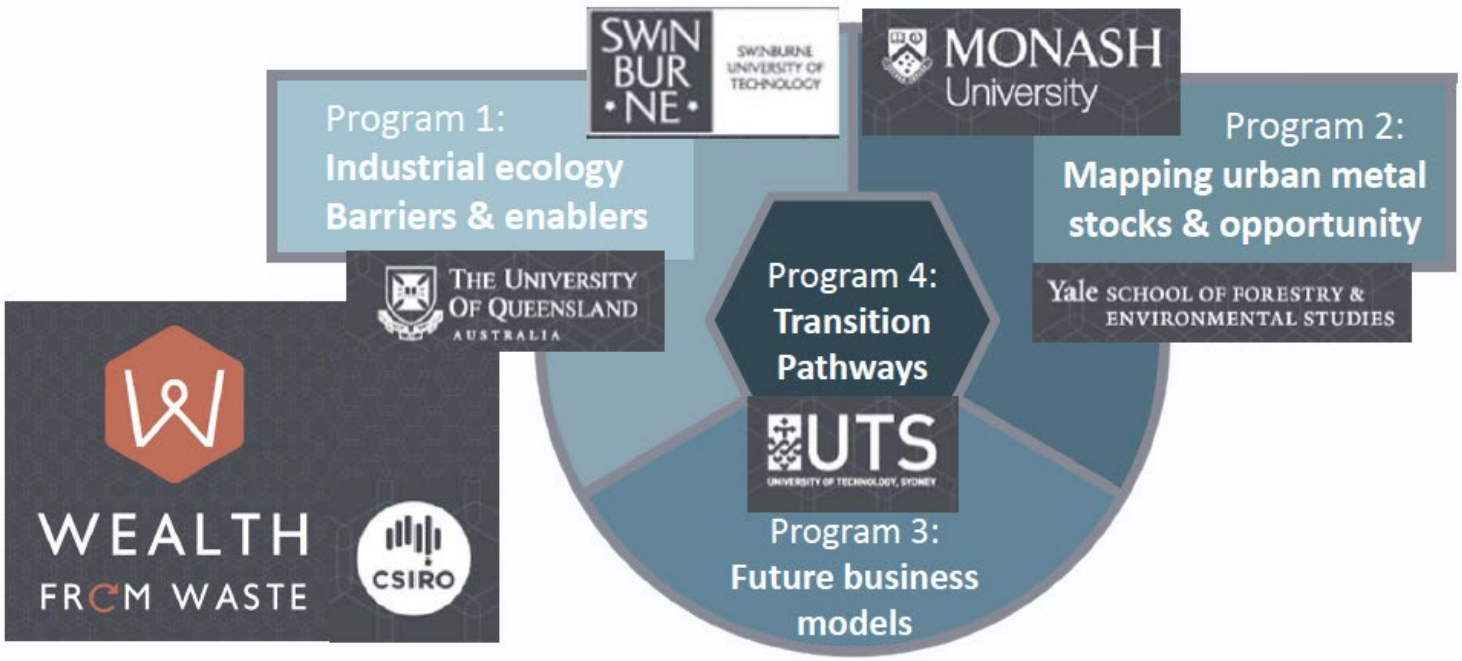



**Todays known reserves leave a 30Mt shortfall in 2050 in available supply from primary resources to meet the worlds historical remand trajectory.**

# Resource productivity – towards a circular economy

# WEALTH FROM WASTE CLUSTER

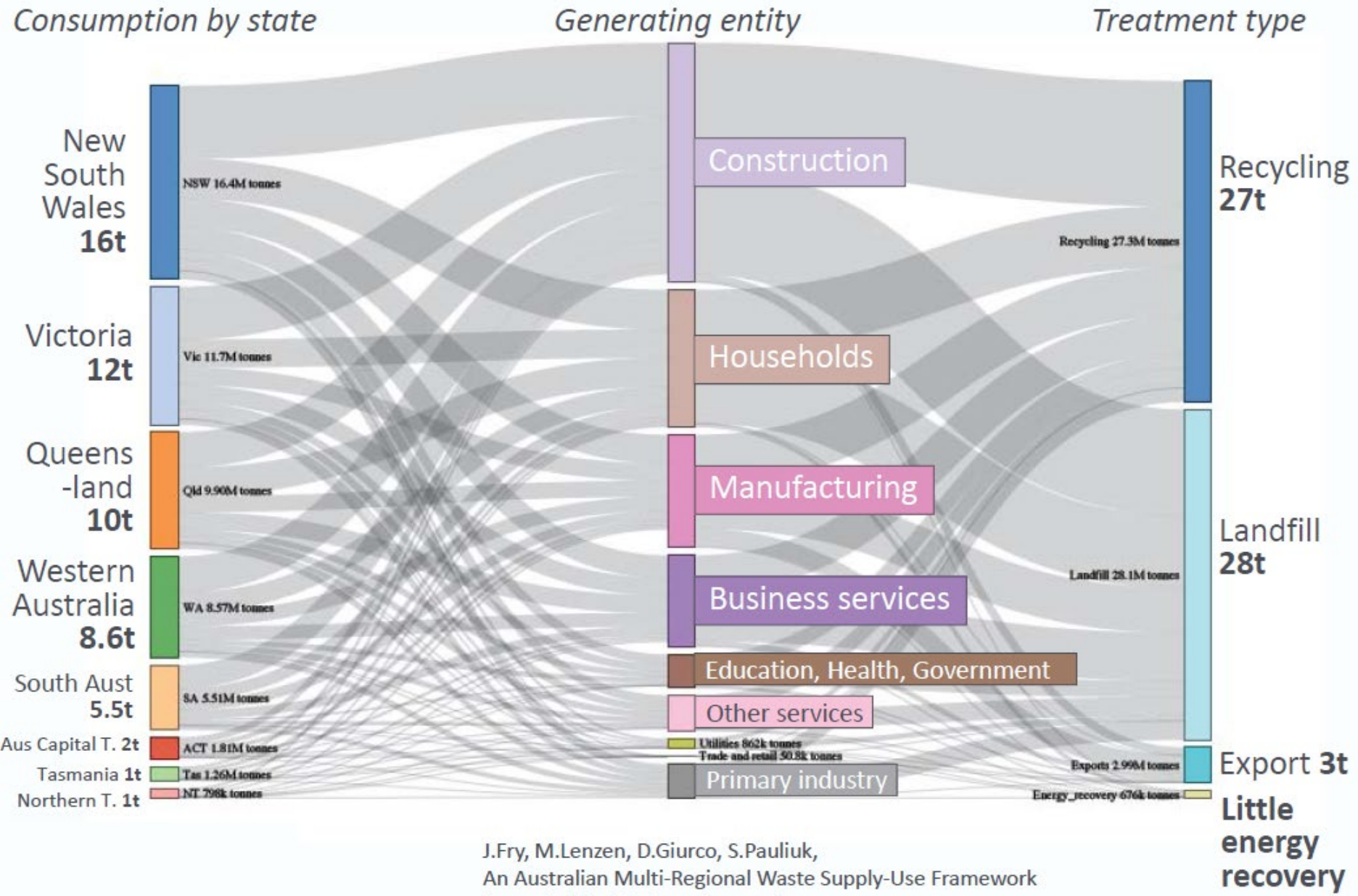
**2013-2017**




*Advancing transition pathways towards the circular economy for metals*

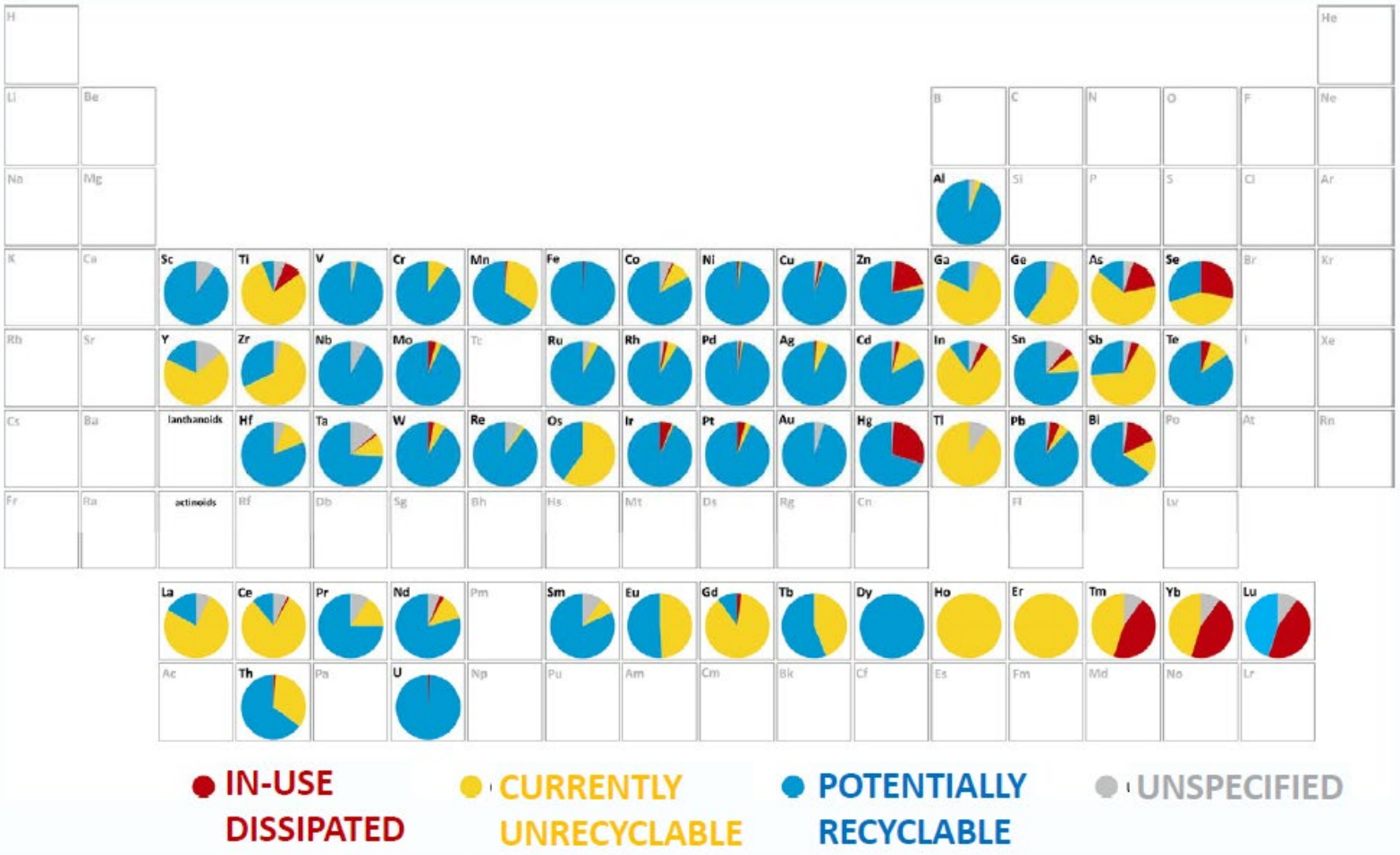
# CLUSTER REFERENCE PANEL & COLLABORATORS

# WASTE FLOWS IN AUSTRALIA



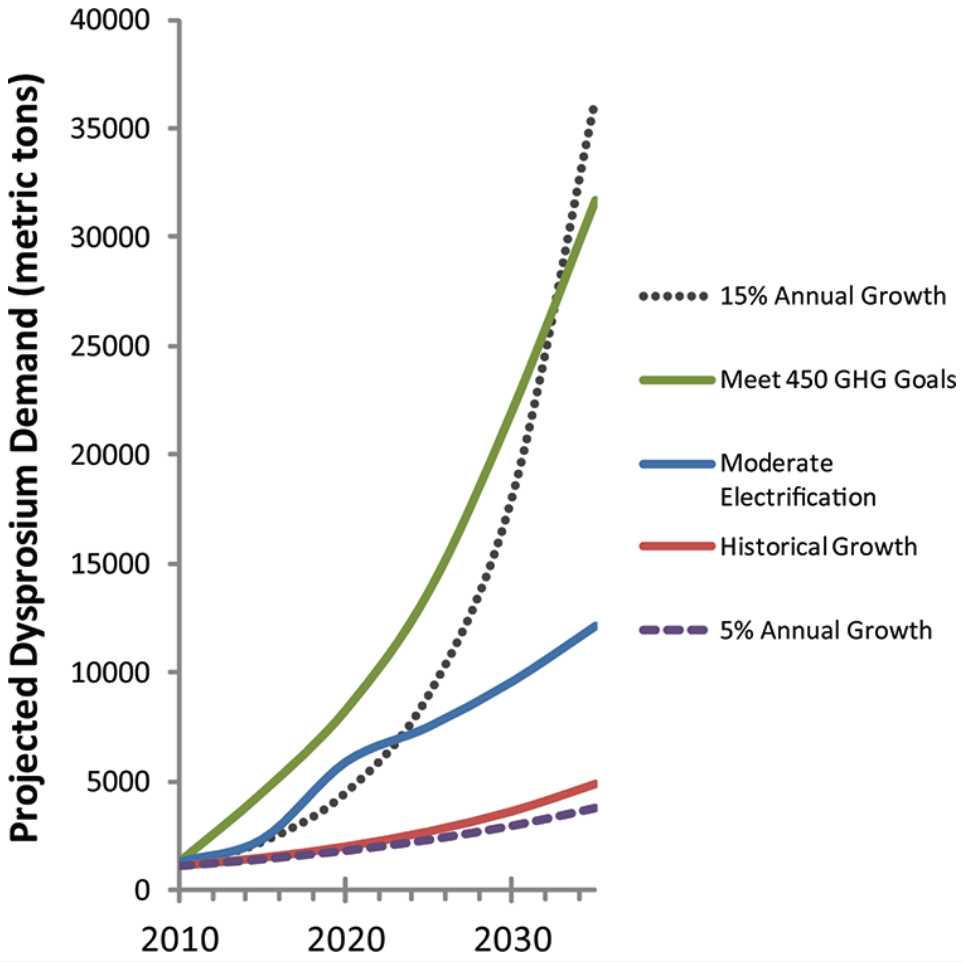

J.Fry, M.Lenzen, D.Giurco, S.Pauliuk,
An Australian Multi-Regional Waste Supply-Use Framework
*Journal of Ind. Ecology* (in press)

# 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

# Changing demand as technology develops – the rare earth conundrum

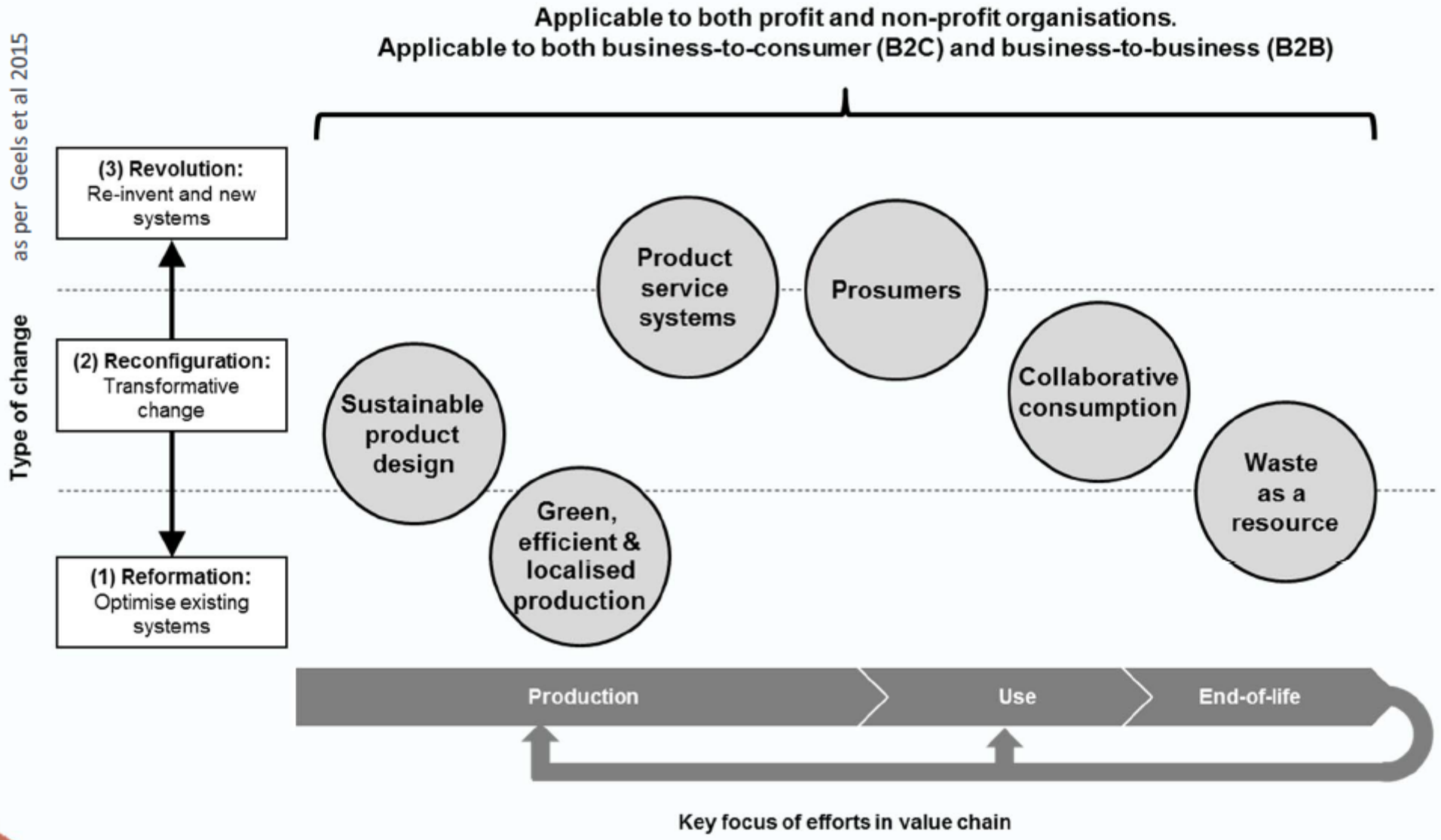



Alonso et al. » Evaluating Rare Earth Element Availability: A Case with Revolutionary Demand from Clean Technologies." *Environ. Sci. Technol.* 2012, 46, 3406−3414

# FUTURE BUSINESS MODELS

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

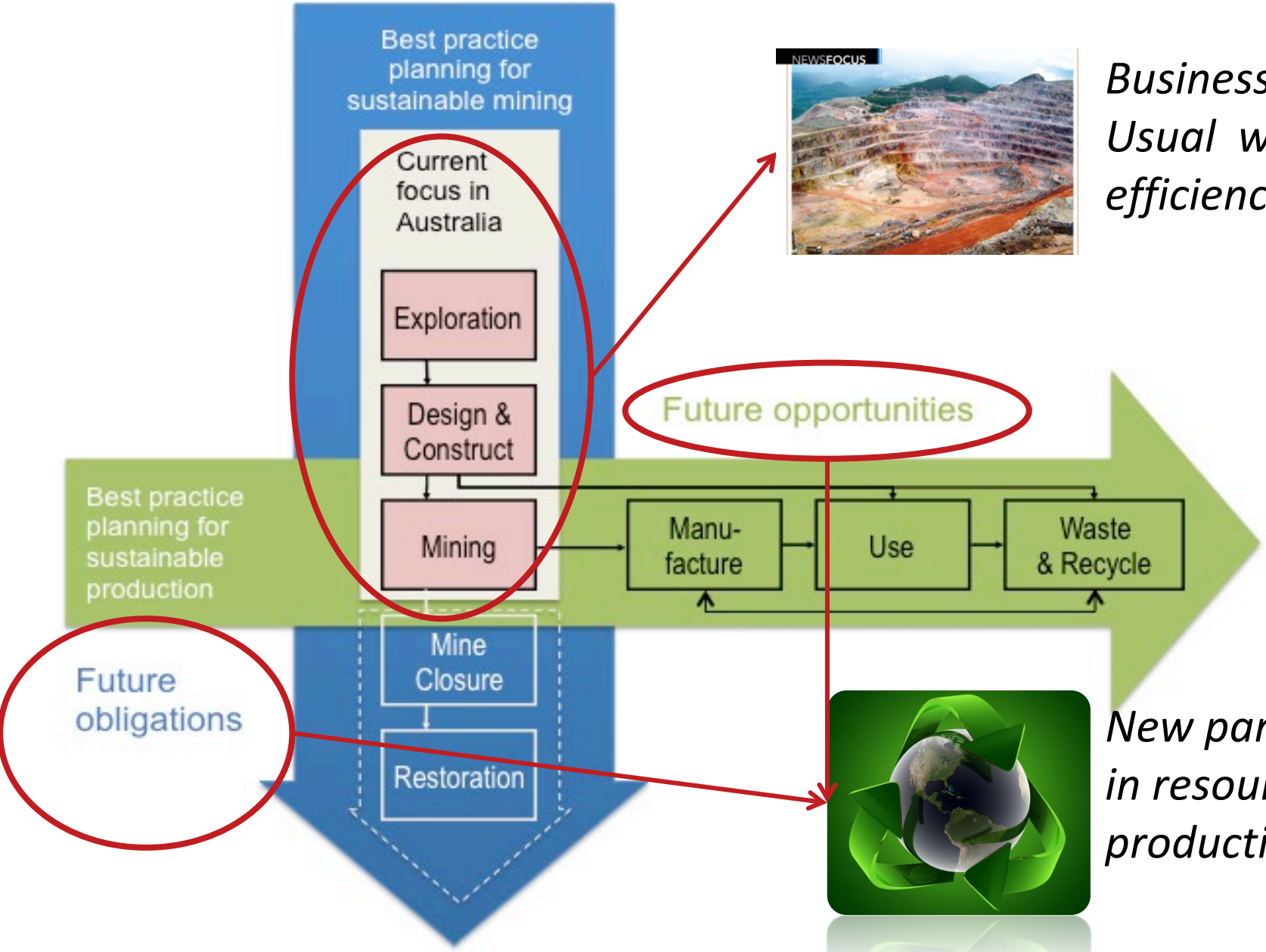
Opportunities and challenges for the circular economy in Australia: the role of innovative business models, unpublished for submission to AJEM



# The role of technology and innovation

# Towards a circular economy – the role of innovation

Photo: David Monniaux







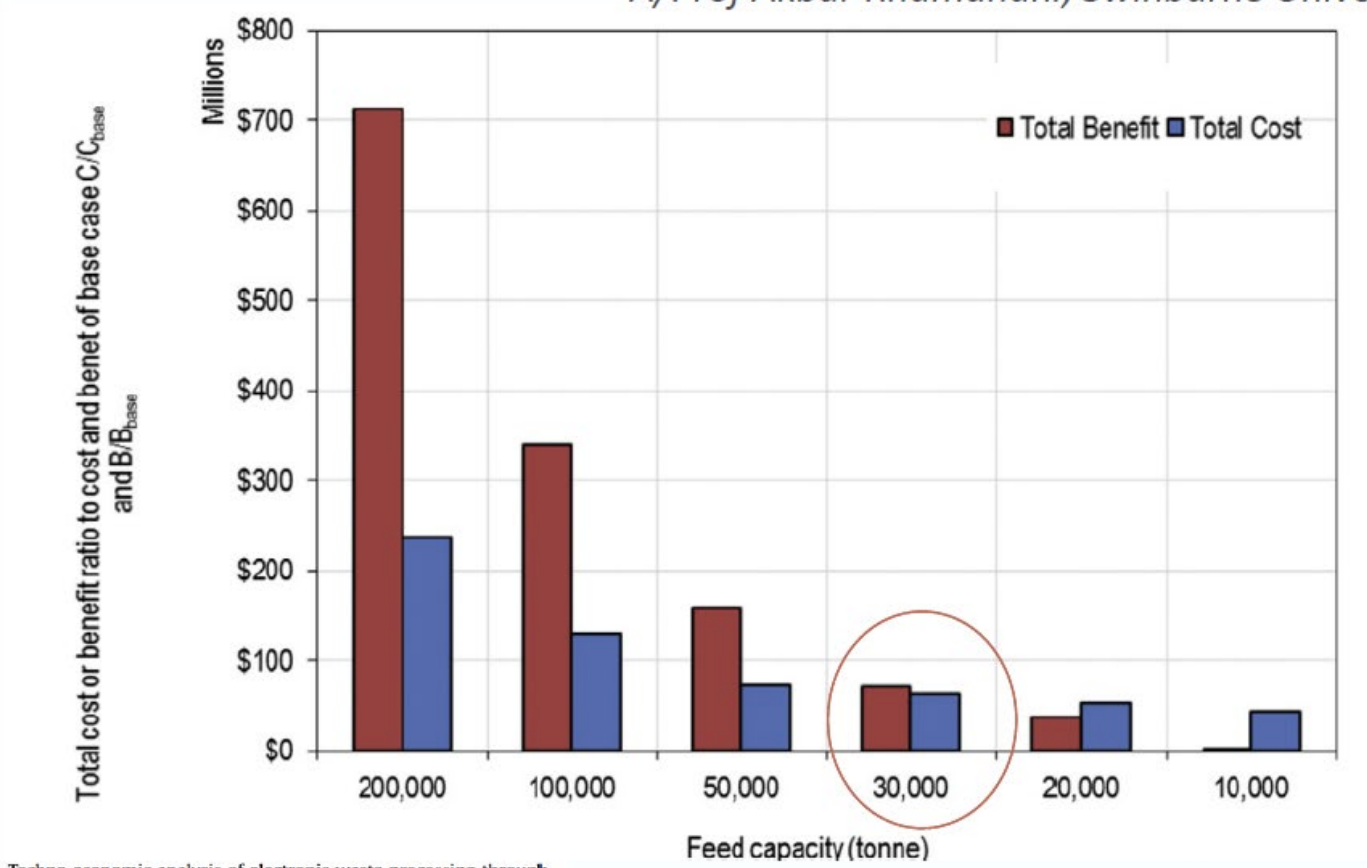
*Business as Usual with extra efficiency*



*New paradigms in resource productivity*

# 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 Ghodrat [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

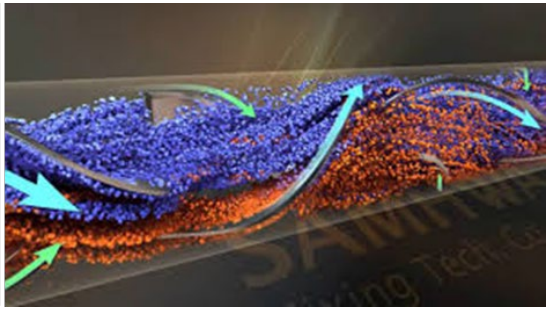
## Establishing a competitive Austrialian high-value chemical manufacturing industry integrated with global supply-chains and markets

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**

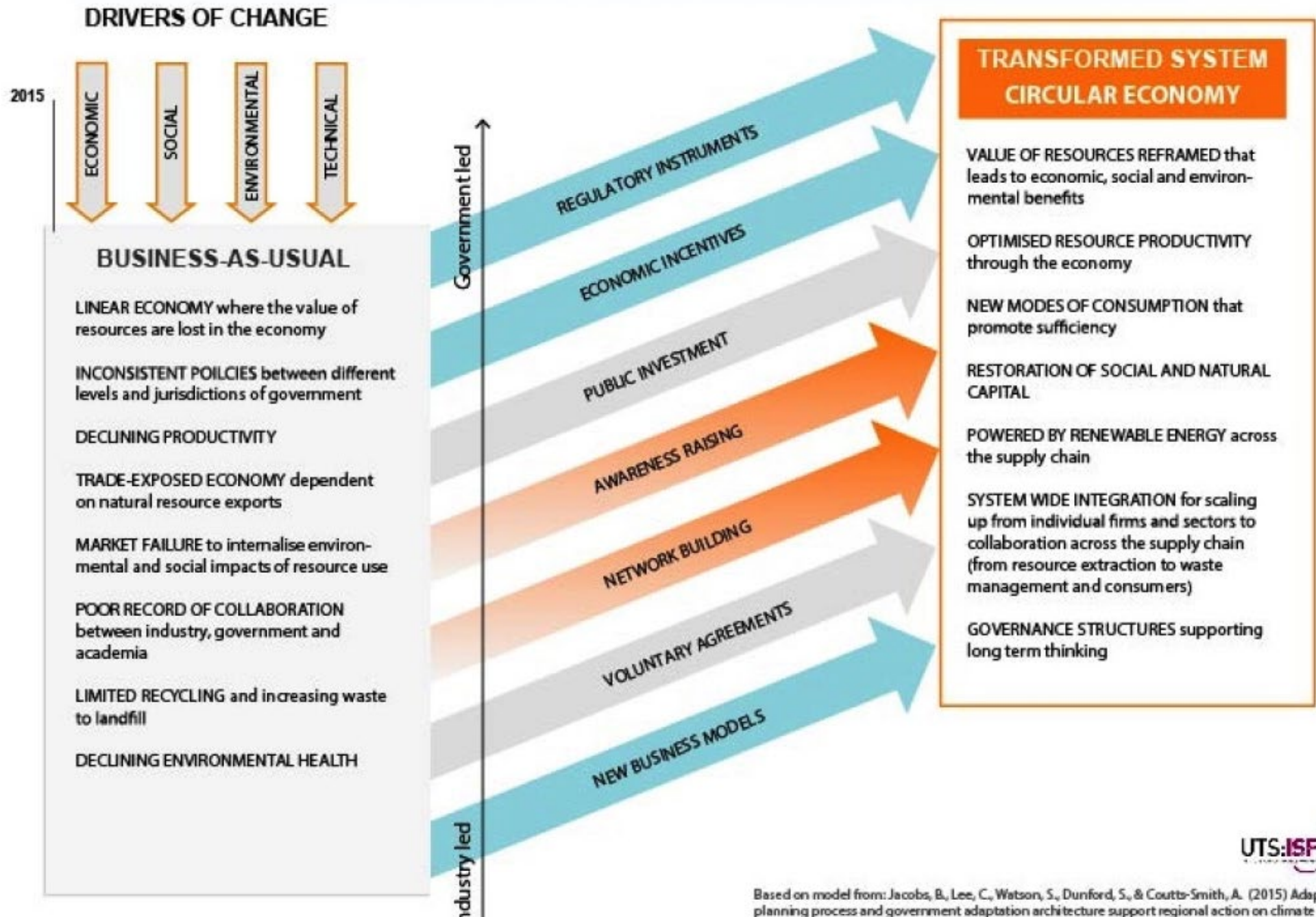
**2. Technological innovations can lead to new business models –** new approaches to smelting, solar powered, mini-scale….for example on a ship docking to process e-waste at islands across the pacific.

**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




UTS:ISF

Based on model from: Jacobs, B., Lee, C., Watson, S., Dunford, S., & Coutts-Smith, A. (2015) Ada
planning process and government adaptation architecture support regional action on climate

# Concluding Comments