# **ACTION AGENDA FOR RESOURCE PRODUCTIVITY AND INNOVATION:** OPPORTUNITIES FOR AUSTRALIA IN THE CIRCULAR ECONOMY

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## ABOUT THE AUTHORS

Institute for Sustainable Futures: University of Technology, Sydney

The Institute for Sustainable Futures (ISF) was established by the University of Technology, Sydney in 1996 to work with industry, government and the community to develop sustainable futures through research and consultancy. Our mission is to create change toward sustainable futures that protect and enhance the environment, human well-being and social equity. We seek to adopt an inter-disciplinary approach to our work and engage our partner organisations in a collaborative process that emphasises strategic decision making. For further information visit www.isf.uts.edu.au

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# TOWARDS A PROSPEROUS FUTURE

## New conversations are needed to build responsible prosperity in Australia

This action agenda aims to bring focus to the importance of resource productivity and innovation as themes of national significance.

The agenda identifies new frontiers of innovation in a circular economy by seeking connection between stakeholders and sectors whose current interactions are limited. For example, by collaboration between researchers and industry in the mining, manufacturing and waste sectors. These are traditionally thought to be discrete parts in a linear supply chain, yet each are design nodes for creating value in a circular economy.

Our future is pervasively digital; by connecting this digital era with increased energy and resource productivity, we can shape a proud economic and social future in an environment ready to sustain new generations.

Our ambition with this call to action is to seed new conversations and collaborations - between business, academia, government and the community - needed to drive a new wave of responsible prosperity for Australia in the Asian Century.

The World Economic Forum estimates the global material cost savings of a Circular Economy could be

**$US 1 trillion**
**per year by 2025**[1]

Based on Australia's relative share of global GDP the value of a Circular Economy could be

**$AU 26 billion**
**per year by 2025**[2]

The material value of global e-waste is estimated to be

**€EU 48 billion**
**in 2014**[3]

Metal contained in wastes streams in Australia is worth more than

**$AU 6 billion**
**per year** and equivalent in volume to **50% of total metal consumption**[4]

Making the most of opportunities in a collaborative economy worth

**$AU 9.3 billion**
in additional value for Australian businesses[5]

1. World Economic Forum (2014), Towards the Circular Economy: Accelerating the scale-up across global supply chains. Available from: http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf

2. Based on World Bank 2013 estimates at http://www.worldbank.org/

3. UNU Global E-waste Monitor (2014) Available from: http://i.unu.edu/media/unu.edu/news/52624/UNU-1stGlobal-E-Waste-Monitor-2014-small.pdf)

4. Golev and Corder (2014) Available from: http://wealthfromwaste.net/wp-content/uploads/2014/11/WfW_IE_Global_Systems_Report-2014.pdf

5. Deloitte Access Economics (2014), The Collaborative Economy. Available from: http://www2.deloitte.com/au/en/pages/economics/articles/collaborative-economy-unlocking-power-of-workplace-crowd.html

# FOUR OPPORTUNITIES FOR AUSTRALIA'S FUTURE

## 1 Replenish stocks and rethink value

Our people, our planet, our policies and our practices are stretched to their limits and need radical alignment to support long-term prosperity. Now is the time that Australia must focus on improving its economic productivity, competitiveness and sustainability. The Australian economy has prospered off the back of a strong resource and mining boom, but at the same time stocks of natural capital are depleting, affecting the future of other industries. Australia needs to build a productive economy that preserves and replenishes stocks of natural capital rather than degrading them.[6]

- Australia should establish a national system of environmental and waste accounts, recognising both are valuable resources.

We need to rethink the value of resources, acknowledging value not just when first sold, but across their full lifecycle. By **adopting the "take-make-recreate" approach of the circular economy** Australia can go from being a global leader in primary resource production to being a leader in generating value through resource productivity. This opportunity applies to manufacturing, construction, transport, logistics and the waste sector. The circular economy provides a framework for **connecting Australian industries to a global transition** towards sustainable futures.

- Rethinking value requires raised awareness, a digitally-enabled skill-base, and alignment between policy and industry that promotes innovation.
- A new business focus is needed for delivering long-term economic and social value whilst improving the productivity of energy, water, materials and knowledge.[7]

6. Wentworth Group of Concerned Scientists (2014), Blueprint for a Healthy Environment and a Productive Economy

7. Resource productivity is defined by UNEP as the economic output per unit of natural resource input considering materials, energy, water and GHG intensity. UNEP (2015), Indicators for a Resource Efficient and Green Asia and the Pacific - Measuring progress of sustainable consumption and production, green economy and resource efficiency policies in the Asia-Pacific region, Schandl, H., West, J., Baynes, T., Hosking, K., Reinhardt, W., Geschke, A., Lenzen, M. United Nations Environment Programme, Bangkok.

## 2 Design for renewable energy and resource cycles

The renewable energy revolution is arriving with US$270 billion invested globally last year.[8] It brings significant reductions in the cost of renewable electricity and a trend towards decentralised energy systems that is disrupting patterns of centralised supply. Australia has an opportunity to **couple renewable energy to value-add in other sectors**, including advanced manufacturing, mining and minerals processing and future transport—**boosting resource productivity**.

- Australia can tap into its vast solar resources to power mines, and to drive energy intensive minerals processing operations. Considering the high embedded energy in exported mineral products, this presents a clear opportunity for Australia to add value to its exports, powered and processed by clean energy.
- Renewable energy can be coupled with heavy industry and manufacturing, future proofing current industries in adapting to a carbon constrained world and supporting the emerging renewables industry. For example, hybrid technologies can be deployed that substitute fossil fuel inputs with bio-energy or solar thermal energy.
- Recycling, reuse and remanufacturing processes rely on cheap energy and logistics to be viable. With the greater uptake of renewable energy to power these processes, old limits to cycling resources are overcome. In addition, the organic materials separated from urban, industrial and agricultural waste streams are an under-utilised resource that could easily be harnessed for energy.

At the same time, growing rates of consumption and new consumer awareness are driving an increasing emphasis on social and environmental impacts of complex global supply chains. There is greater expectations for **responsible sourcing of resources and stewardship along the supply chain**, supporting fair labour standards and eliminating adverse effects on human and environmental health. New collaborations and information exchange across industries along the supply chain are critical for assuring that resources and products provide a pathway to second life through reuse, remanufacturing or recycling.

8. UNEP's 9th Global Trends in Renewable Energy Investment 2015, available from: http://fs-unep-centre.org/publications/global-trends-renewable-energy-investment-2015

By bringing together business, research, technology and policy, we can deliver the skills, products and services to sustain prosperity at home and in our region.

› The Steel Stewardship Forum in Australia is fostering collaboration between major stakeholders along the supply chain to provide assurance in the delivery of responsible steel. The Aluminium Stewardship Initiative has a similar focus on sustainability and transparency in the aluminium supply chain. There is significant scope to transform systems and processes to give greater focus to responsible markets beyond end-of-first-life and beyond the metals sector.

## 3 Harness disruptive innovation for production and consumption 2.0

Disruptive innovation must be thoughtfully harnessed to make sure it improves the well being of people and the planet. New materials and digital technologies, advanced and additive manufacturing, and open innovation are **transforming conventional business practices**. Australian firms can influence the design of products for easy remanufacturing and recycling, whether made locally and overseas. These innovations can overcome barriers affecting traditional value pools in Australia's manufacturing and processing industries, such as the distance to market and size of the market.

› Real time digital tracing and tracking of materials enables the alignment of business models with effective resource management. The greater transparency of material flows and ownership can shift the business model from focusing on the volume of sales to a more value-added service oriented approach.
› 3D printing, with open innovation, could enable distributed manufacturing of niche components for machines with lower material inputs. It could also enable the timely replacement of non-durable parts of products, extending operating lifetimes with shorter downtimes.

Innovation is not limited to technology and materials; innovations are also emerging in business models, and the way consumers own and use products and services.

› The success of new organisational structures, including social enterprises and B-corps, demonstrate the significant opportunity to produce valuable products or services, while delivering positive social outcomes and engaging consumers. Social enterprises are already delivering social value and empowering communities across regional Australia in the waste and resource recovery industries.
› The ubiquity of mobile and internet technologies and the pervasive ability to communicate is changing the way people think about products and services. Consumers are able to exploit their assets and the idle assets of others through new sharing platforms, reducing the demand for new resources and products. The growing sharing economy captures the underutilised capacity of resources through new business models that prioritise access to products rather than ownership.

## 4 Leverage know-how into new networks and markets

Australia starts from a vast base of knowledge, skills, and technological and technical know-how, that can be aligned to provide a competitive advantage for capturing new markets and growing strategic networks.

› Australia is a leading provider of advanced services to mining, with more than half of the software used globally for operating mines developed in Australia. This know-how can be applied to access new markets in waste and unconventional resources.
› Australian technologies for mining and minerals processing can be exploited for delivering value from above ground metal waste streams, including targeting the fast growing market of e-waste. Not only will Australia access new economic value, this could help combat the global problem of illegally dumping and trading of e-waste worth more than US$19 billion, often to countries where human health and environmental standards are less stringent.[9]

8. http://www.unep.org/newscentre/Default.aspx?DocumentID=26816&ArticleID=35021&l=en

# A CIRCULAR VISION

## KEEP THE GOOD TIMES ROLLING

Economic growth has prospered in recent decades in Australia, fostering a good time mentality. During the twilight years of the mining and construction boom rising commodity prices and the associated high Australian dollar masked a **decline in Australian productivity** in all sectors putting pressure on governments and taxpayers. The high dollar undermined the competitiveness of traditional manufacturing while the thriving resource sector raided manufacturing for skilled workers.

While the good times continued, governments and industry were complacent and failed to adequately plan for new drivers of prosperity. In a post-mining boom Australia, businesses operate with great uncertainty about the future. Globalisation has reduced trade-barriers, with policy initiatives such as the China-Australia Free Trade Agreement, increasing competition with low-cost economies. Increasing prices and shrinking revenues are undermining the competitiveness of the traditional economic base highlighting the need to **accelerate a shift towards a new competitive base active in professional services, advanced manufacturing, business model innovation and value-added products.**

At the same time, consumers are better informed and more engaged about the environmental and ethical impacts of resource production and use. A social licence to operate is an increasingly important part of doing business. See Figure 1 for the diverse drivers impacting Australia's economy.

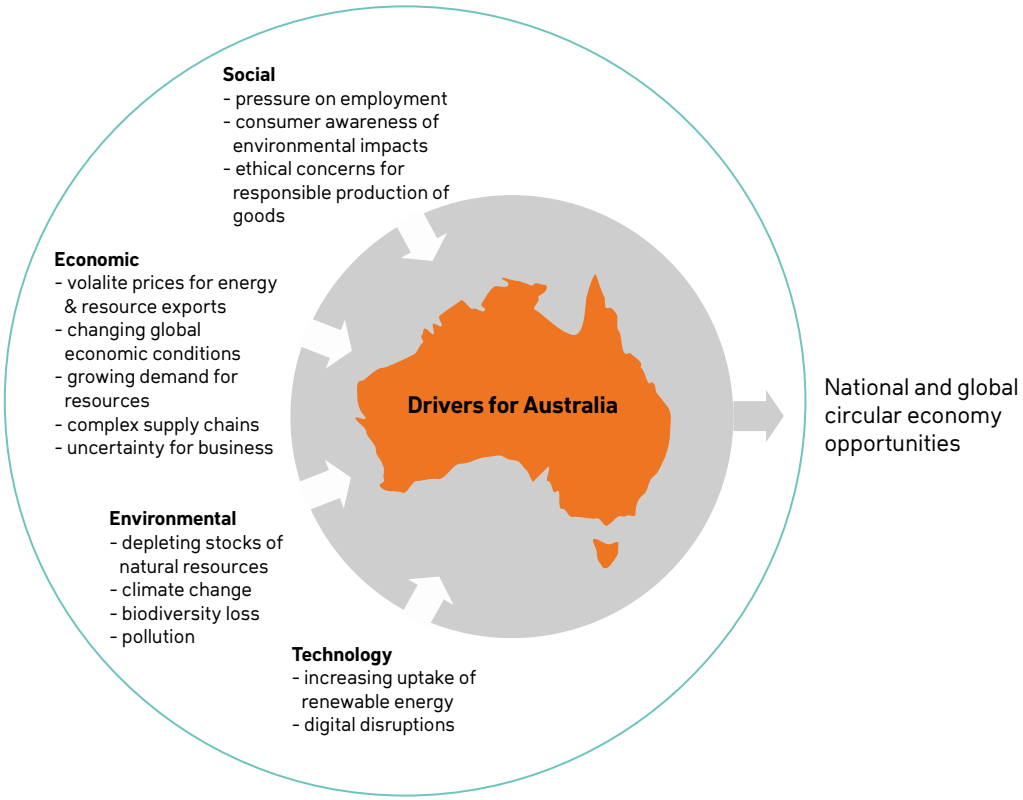



**Figure 1: Drivers for Australia towards leadership in a circular economy**

# THE NEW TAKE-MAKE-RECREATE APPROACH

Amidst these economic and environmental drivers, the Australian economy is particularly vulnerable because the resource industries contribute a disproportionate impact on people and the environment relative to their economic value that accumulates along the supply chain (Figure 2).

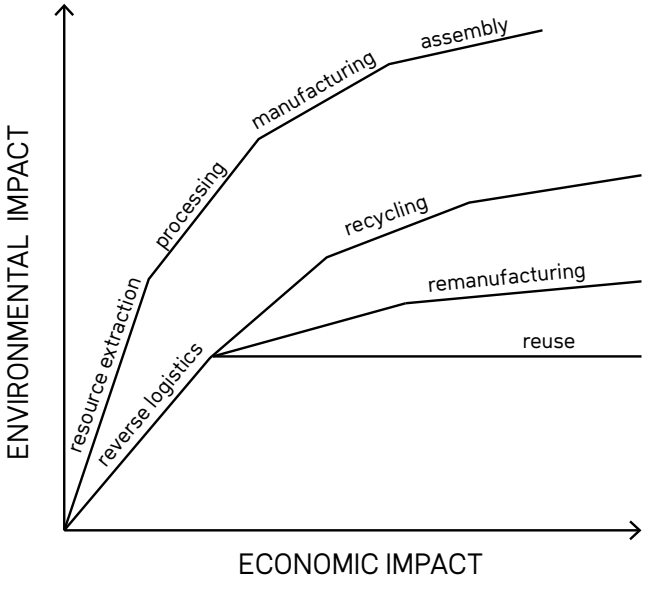
The **opportunity for Australia in the circular economy**, that promotes a new 'take-make-recreate' approach to managing resources, engages directly with how we think and use resources to derive value. It is also **gaining considerable traction amongst Australia's key trade partners** in Europe, China and Japan.[10]

At the core of this alternative economic model is re-thinking design to maintain the value (economic and functional) of resources (energy, water, materials, knowledge) in the economy. This is achieved by re-energising and re-imagining traditional practices of reuse, repair, remanufacture and recycling.

This is in contrast to the traditional 'linear model' where resources are extracted and their value is diminished during a single-use phase prior to disposal or lost from the economy as pollution.

The circular economy goes far beyond cycling materials. Rather it refers to a broad suite of strategies that includes technology innovation as well as business model innovation, new design thinking and novel modes of consumption. Furthermore, by taking a whole-systems view it aims to exploit synergies at the interface of all of these. These ideas are discussed in the context of future mobility systems, see Figure 3 (overleaf).

**Distinct from traditional primary resource production that has pursued an approach of 'bigger, deeper, faster' the opportunities in the circular economy are about being smarter and embracing a 'take-make-recreate' strategy.**




10. For example World Economic Forum Towards a Circular Economy Report, 2014 available at: http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf; The Circular Economy Strategy Roadmap available at: http://ec.europa.eu/smart-regulation/impact/planned_ia/docs/2015_env_065_env+_032_circular_economy_en.pdf; Ellen MacArthur Foundation Circular Economy Reports Volumes 1-3 available at: http://www.ellenmacarthurfoundation.org/books-and-reports; Su, B. et al., 2013. A review of the circular economy in China: moving from rhetoric to implementation. Journal of Cleaner Production, 42, pp.215–227.

**Figure 2: Primary resource industries contribute disproportionate environmental impact relative to the added value. Secondary lifecycles can reduce environmental impact and add value. Inspired by Clift and Wright, 2000**

# OBSERVING LIMITS AND FOSTERING A REGENERATIVE APPROACH

The circular economy has limits. While current economic growth trajectories continue to be linked to rising resource consumption, future reuse and recycling can only meet part of the future increase in demand – it does not offset total demand. This imbalance is intensified by a lag between when materials are input in to the economy and when they become available for reuse.

It is theoretically impossible to continually reuse and recycle materials without some losses and environmental impact (see Figure 2) and the upper limit is defined by physical and economic constraints. Even if we can design out material losses to the environment, for example preventing the corrosion of metals; the collection, sorting, and reprocessing are costly and use significant amounts of energy. Increasing the input of renewable energy is critical to maximising the overall effectiveness of the circular economy but closing the loop is not sufficient unless we also address rate of consumption. For example, implementing a car-sharing scheme without also focussing on fuel efficiency and the number of trips taken undermines the environmental benefits because the use phase has greater impacts than the manufacturing phase.

This highlights the importance of new consumption models that **decouple material use from economic growth** and encourage sufficiency to reduce total demand. It also highlights the need to foster a regenerative approach that equates to **doing more good as opposed to doing less bad**.

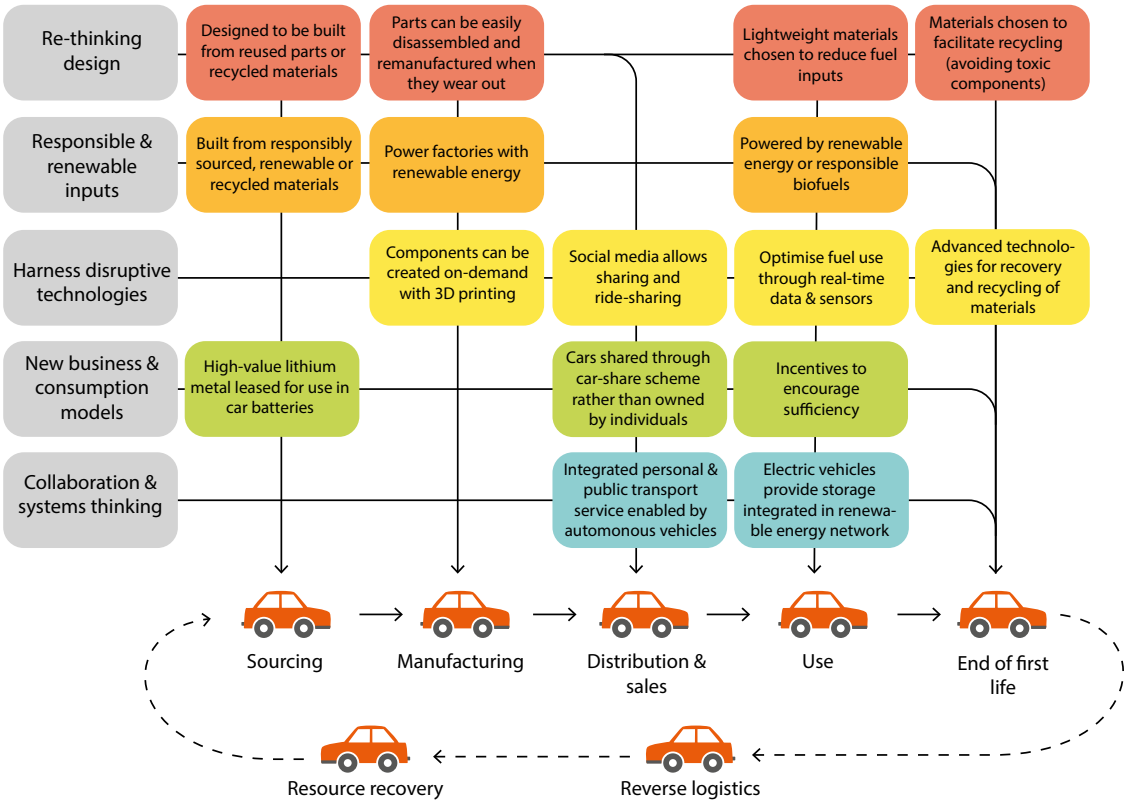



**Figure 3: Circular economy principles applied to future mobility**

# Wealth from Waste Cluster

## Inspiring smarter Australian resource industries of the future

The Wealth from Waste Cluster is an international collaboration of research groups led by the University of Technology Sydney (UTS), with Monash University, the University of Queensland, Swinburne University of Technology and Yale University.

In partnership with CSIRO and enabled by support from the Flagship Collaboration Fund and participating universities, the Cluster is charting a pathway to enable Australia's metals and minerals industries to prosper in a future circular economy. The research is about helping Australia expand its resource base from being a leader in primary resource production to also being a front-runner in enabling the emerging secondary resource markets, technologies and practice.

Distinct from traditional primary resource production that has pursued an approach of 'bigger, deeper, faster' the opportunities in the circular economy are about being smarter and embracing a 'take-make-re-create' strategy.

### Getting the fundamentals right

Australia is recognised as a global leader in providing mining technical know-how and engineering services to support the extraction, recovery and processing of metals from primary resources that may also be applicable to accessing value from 'above-ground mines'. A key challenges that must be overcome, and the focus of research at the University of Queensland and Swinburne, evaluates the implications of basic science specific to the new combinations of metals that are combined in urban ores and mine wastes. A better understanding of the fundamentals makes possible the modification of processing equipment and techniques designed for processing natural ores.

### Better data

Analogous to geological mapping of primary deposits, the focus of Cluster researchers at Monash and Yale universities are obtaining better data for characterising and quantifying metal accumulation behaviours and distribution within urban areas, and average life cycles of metal bearing products. This allows smarter planning and organising of collection and sorting systems.

### Design-led business models

New design-led circular business models are vital for provoking change across the whole supply chain. While contemporary Australian industries engaged in the resource sector tend to be focussed at the front-end of the supply chain with other players operating the recycling industries at the back-end, developing new capabilities for managing metal flows along the supply chain will be vital for capturing accumulated value in emerging secondary markets. UTS researchers see clear indicators from international markets and the emergence of very innovative SMEs, focussed on designing their products and services for multi-use cycles. These opportunities are yet to be seized by the Australian metals industries.

UTS UNIVERSITY OF TECHNOLOGY, SYDNEY

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# CHARTING A PATHWAY FOR TRANSITION

Key stakeholders need to foster new approaches that realise environmental, economic and social benefits within a circular economy. Figure 4 shows the importance of new connections between stakeholders and sectors to deliver the four opportunities for Australia. The nodes identify opportunities that are currently being seized and those we identify to be significant. These are elaborated below for key stakeholders. We propose a number of achievable near-term strategies for governments, industry and the higher education sector.

## POLICY COORDINATION

Governments have already begun taking meaningful steps towards enacting policies that promote resource productivity and circular economy. For example the national National Television and Computer Recycling Scheme currently under review[11], and State based Container Deposit Legislation.[12] There remains a need to coordinate and expand existing initiatives for enabling future innovation and environmental success.

Key opportunities for federal, state and local government to take a leadership role in charting a pathway towards a prosperous Australia in a circular world, include:

### Embed resource productivity in a coordinated policy agenda

- Targeted, coordinated and consistent policies across federal, state and local governments on resources and energy productivity integrated with national waste management policy is needed, including levies on resource extraction and waste disposal, appropriate targets for recycling and resource productivity, and ambitious targets for renewable energy.

### Promote a market for secondary resources and products

- Public procurement policies, e.g. NSW Government Resource Efficiency Policy (GREP)[13], have significant potential to promote the purchase of goods made with secondary inputs and to de-risk investment in new resource management infrastructure.
- Expanding the significant steps towards supporting the return phase of products at end-of-life should be a priority, e.g., via product stewardship regulations and container deposit legislation.

### Create an enabling environment for technology and business innovation

- Governments can play an important role in creating the optimal conditions for innovation in technology and business by de-risking investment in R&D and new infrastructure. Key to this is encouraging industry-university collaboration for innovation through tax incentives that foster private investment in R&D.
- In addition to support for R&D, governments can enabledeployment towards commercialisation, e.g., as demonstarted by international policy initiatives such as UK's Catapult Initiative.[14]

11. More details including about the operational review available at: http://www.environment.gov.au/protection/national-waste-policy/television-and-computer-recycling-scheme

12. A detailed review of CDL available at: https://www.uts.edu.au/research-and-teaching/our-research/institute-sustainable-futures/our-research/resource-futures-0

13. For more details on NSW government policy for leadership in resource productivity see http://www.environment.nsw.gov.au/government/140567-resource-efficiency.htm

14. The Catapult Centres are designed to transfer UK innovation towards commercial outcomes. The 7 physical centres earn competitive funding from private investment and core public funding for long-term investment in infrastructure and expertise. More details available at: https://www.catapult.org.uk/

# COORDINATING TECHNICAL, SOCIAL AND SYSTEM INNOVATIONS

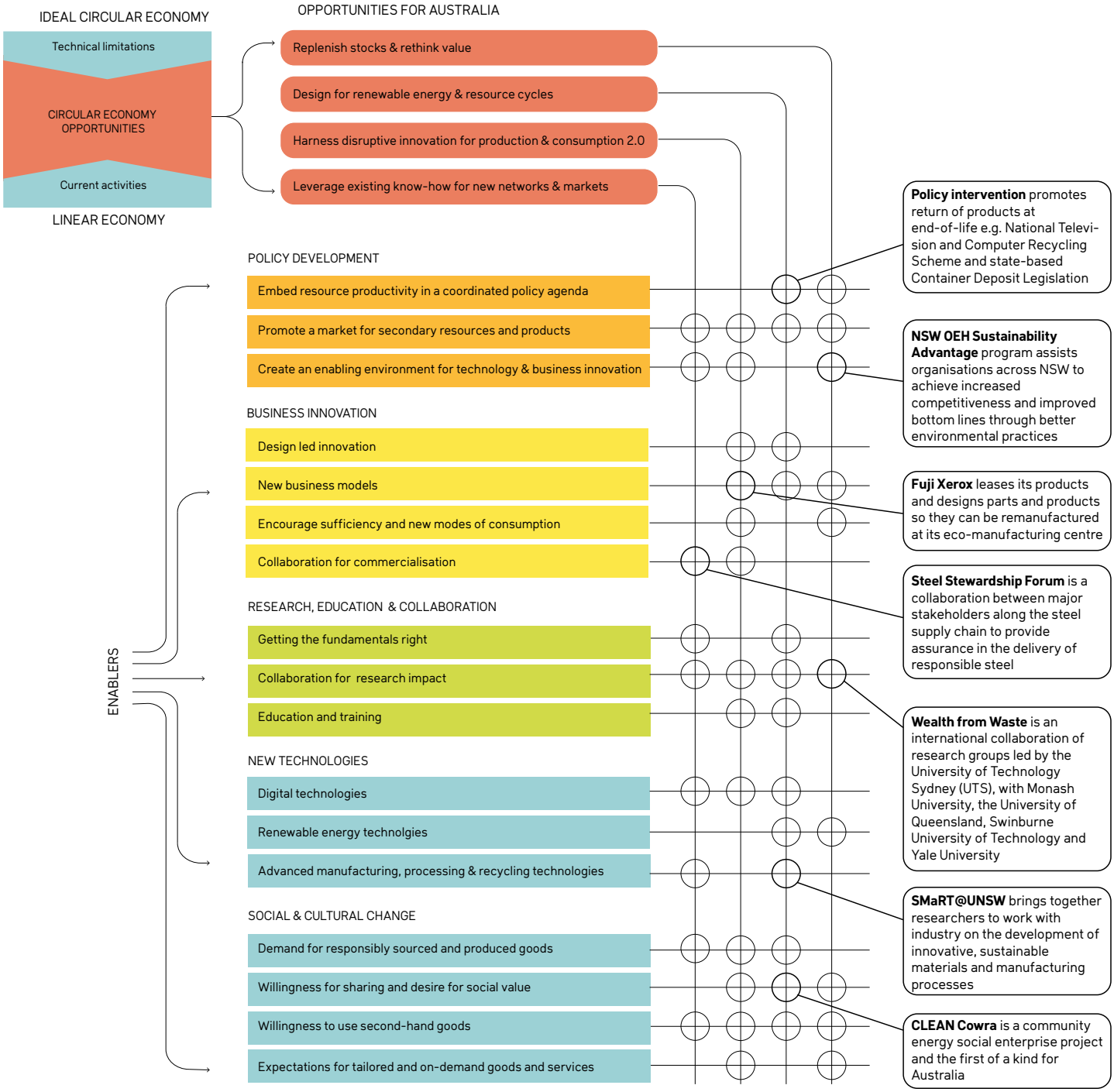



**Figure 4: Defining the opportunities and characterising enablers for a circular economy**

# BUSINESS INNOVATION

There is a unqiue opportunity for Australian businesses to be the vehicles for coordinating technological, social, and system innovation in the Asia Pacific region. This requires re-conceptualising the function of business and reframing perceptions of value creation along the supply chain.

Given the complexities of competing in a globalised economy, which often requires having capabilities across a range of disciplines, it is increasingly challenging for individual businesses to maintain competiveness. In this context, innovative businesses are taking leadership; we have seen a transition from proprietary models of knowledge to open source that emphasises collaboration and sharing. Business models are creating new economic value by designing for closed-loop products and building loyal relationships with customers.[15] Specific opportunities for business to foster a circular economy are identified below:

## Design-led system innovation

› The globalised digital marketplace is leading to a shift from large, vertically integrated corporations to the rise of the 'micro-multinationals' that are small, agile and aggressive innovators.[16] Significant opportunities for energy and resource efficiency are being seized through design-led innovation from IT-enabled demand management systems to 'virtualisation'.

## New Business Models

› Notwithstanding the importance of disruptive technologies and materials, innovation in business models is central to reframing value. New business models for the circular world allow businesses to diversify their revenue streams, engage with new markets, and de-risk in light of resource constraints. New value is being created through five archetypal new business models[17]:

1. Substitute with renewable inputs
2. Maximise material and energy efficiency
3. Create wealth from wastes
4. Adopt a stewardship model
5. Promote access over ownership.

Across these archetypes there is a clear shift from product to service oriented models supported by digital sharing platforms, and greater emphasis on providing niche offerings to the consumer.

## Encourage sufficiency and new modes of consumption

› A parallel focus on sufficiency strategies is critical; incentivising responsible use of products and services, designing for long-life, providing warranties for secondary products and offering virtual over physical upgrades. While new business models that reconceptualise waste as a resource have the potential to achieve an increase in resource use productivity, the inherent reliance on waste generation has the potential to undermine a priority for waste prevention.

## Collaboration for commercialisation

› As well as open source models, new strategic sector-wide partnerships can promote circular outcomes, e.g. collaborations to provide scale-up solutions in delivering reverse logistics such as Mobile Muster for recycling mobile phones.
› Industry-university partnerships can also be fostered to deliver commercial outcomes by longer-term engagement with universities through work experience for researchers and funding PhD projects.

15. Chesbrough, H.W. Why Companies should have open business models? MIT Sloan Manag. Rev. 2007, 48, 22–28

16. For further discussion see: https://www.uts.edu.au/about/uts-business-school/news/micro-multinationals-quietly-reshape-manufacturing

17. The archetypal business models for a circular economy are derived from a comprehensive review: Bocken, N.M.P. et al., 2014. A literature and practice review to develop sustainable business model archetypes. Journal of Cleaner Production, 65, pp.42–56.

# RESEARCH, EDUCATION & COLLABORATION

Australia must overcome its poor record for collaboration in research and innovation, ranking 29 out of 30 in the OECD for university-industry collaboration with large corporations and SMEs.[17] This has been recently highlighted by the Australian Technology Network of Universities that recommended a 'rebalance of the research agenda' to better reflect the priorities of industry; as well as advocating for a strong leadership role of governments to incentivise closer university-industry partnerships to support industry-focussed training and education, and co-investment in research.[18]

These recommendations are directly aligned with this Action Agenda for the Circular Economy given the important role of the higher education sector in developing the basic science for driving innovation, providing the IP for commercialising research outcomes, and educating our future government and industry leaders.

### Getting the fundamentals right

› Basic science and fundamental research at universities is important for pushing the boundaries and inspiring technological, social and systems innovation and cultural change. Better data on resource use, material flows and material characterisation provides the new insights that seed the development of the next generation of disruptive technologies and materials.

### Collaboration for research impact

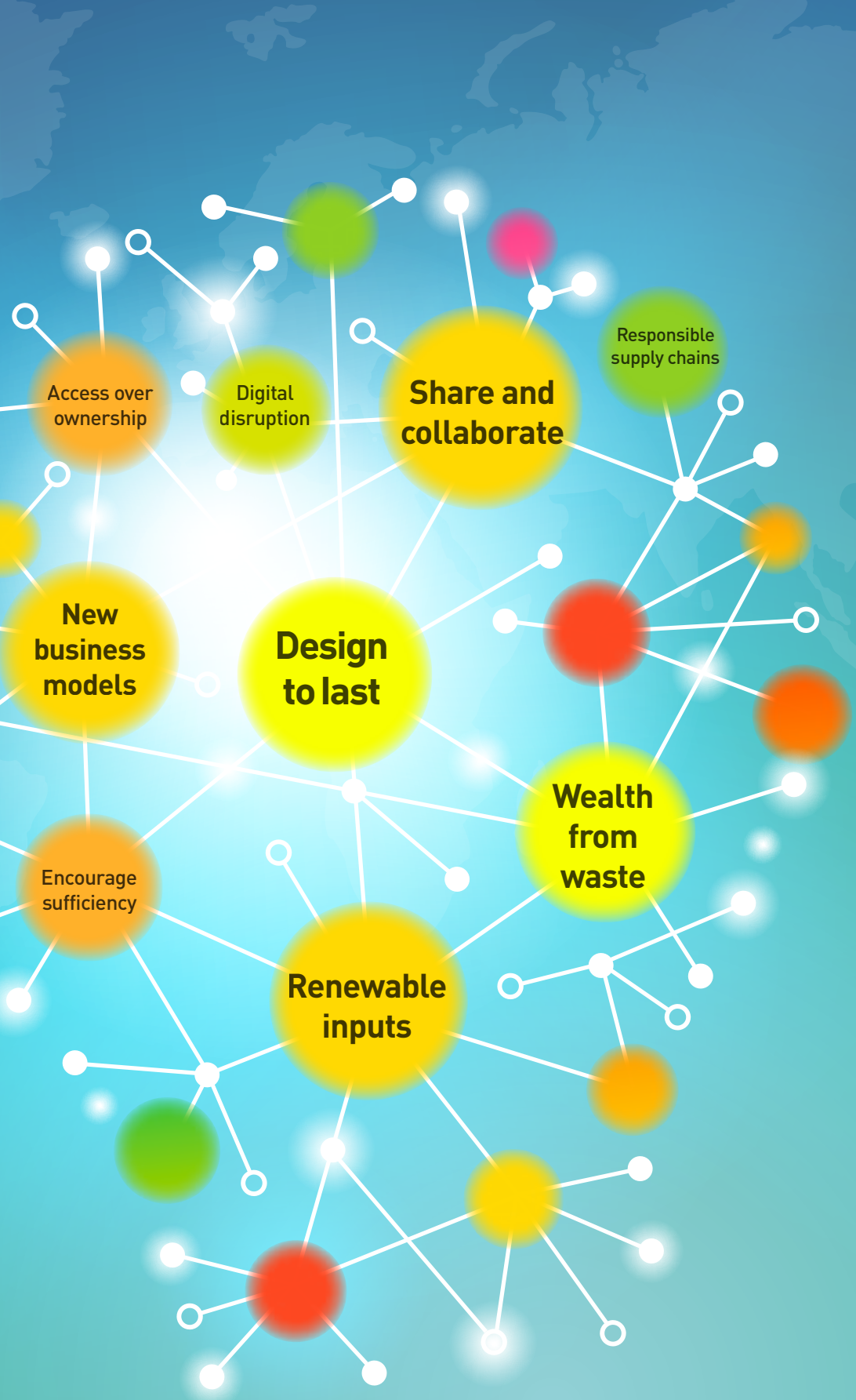
› Universities are responsible for driving basic and applied research towards delivering commercial outcomes and a number of universities are already leading the way in fostering strategic commercialisation collaborations, including via the Easy Access IP program that can provide IP to companies free of charge, as adopted by UTS.

### Education and training

› Significantly, universities educate and train future champions of sustainable design, business management, engineering, architecture and ICT who will be leading the future companies operating in a circular world. With industry and government partners, universities can promote industry focussed outcomes by fostering programs that support work experience placements, research secondments in government and doctoral training, important for the dissemination of knowledge, and promoting industry relevant teaching and research outcomes.

17. OECD, 2013. Science, Technology and Industry Scoreboard 2013

18. Australian Technology Network Universities, 2015. Ensuring Australia ' s Future Competitiveness through University-Industry Collaboration available at: https://www.atn.edu.au/News-room/Latest-News/Collabo-rate-innvoate-or-be-left-behind/.


Access over ownership
Digital disruption
Share and collaborate
Responsible supply chains
New business models
Design to last
Wealth from waste
Encourage sufficiency
Renewable inputs

MORE INFORMATION

To join the discussion and to grow new collaborations that can capture the opportunities for Australia in the global transformation in resource productivity, please contact:

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