



WEALTH  
FROM WASTE

INDUSTRIAL ECOLOGY FORUM “SHIFTING THE  
AUSTRALIAN RESOURCES PARADIGM”

28 MARCH 2014

SYDNEY, AUSTRALIA

OUTCOMES AND FINDINGS REPORT

## **CITATION**

Corder, G.D., Golev, A. 2014. Industrial Ecology Forum “Shifting the Australian resources paradigm”, 28 March 2014, Sydney: Outcomes and findings report. Prepared for Wealth from Waste Cluster, by the Centre for Social Responsibility in Mining, Sustainable Minerals Institute, The University of Queensland. Brisbane, Australia.

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## BACKGROUND

‘Wealth from Waste Cluster’ is a major 3-year (2013-2016) research collaboration that aims to identify economically viable options for the recycling of metals from existing products in Australia. It focuses on ‘mining’ above ground resources, namely metals contained in collections of discarded manufactured products and consumer goods.

The University of Queensland’s Centre for Social Responsibility in Mining leads one of the core research streams – Program 1 “Recycling Systems: Barriers and Opportunities for Industrial Ecology in Australia”. The overall cluster project is led by the University of Technology, Sydney, and also includes Swinburne University of Technology, Monash University and the Center for Industrial Ecology at Yale University, along with an International Reference Panel of experts and CSIRO.

The Industrial Ecology Forum is a part of Program 1 research activities, aimed to provide initial input for detailed investigation into barriers and enablers for higher uptake of leading practices in metal recycling in an Australian context.

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## FORUM AIM AND OBJECTIVES

By drawing on the knowledge and experience of a broad range of stakeholders, this forum aimed to facilitate a pathway forward for greater levels of industrial ecology uptake and practices in Australia, which will deliver substantially higher levels of metals and minerals recycling.

Objectives:

- Establish current status of industrial ecology and recycling in an Australian context.
- Understanding from first-hand experiences of industry, government and research stakeholders the key issues for recycling and re-use of metals and minerals.
- Elicit potential opportunities and enablers for greater uptake based on international leading and emerging practices.

Why attend:

- This is an opportunity to contribute and influence the research program of the Wealth from Waste Cluster, a major research initiative of CSIRO's Flagship Collaboration Fund and the Minerals Down Under and Future Manufacturing Flagship programs.
- To ensure your contributions are incorporated into the project, a second workshop will be held later in the year to update on progress and seek further input.
- Your contribution will help support the planned paradigm shift in Australian recycling systems and subsequent higher levels of metals and minerals recycling.

## FORUM FORMAT AND AGENDA

The forum was held as a half-day workshop, following the Cluster launch breakfast. It included two sessions: the morning session was focussed on the circular economy and Australian national initiatives, and the afternoon session was focussed on recycling sector in Australia. Several presentations by guest speakers from the government, industries, and academia were followed by table discussions with summarising of the main findings at the end of each session. Before the workshop, participants also received via e-mail a background document (reading materials with key summary information derived from authors' publications, Appendix A).

### Forum agenda (28 March 2014)

Part I. Circular economy and Australian national initiatives	
10.30 – 10.40	Welcome – Research and Forum Aims – Glen Corder
10.40 – 10.55	<b>World Economic Forum Circular Economy</b> – Prof Saleem Ali (via video) <i>Director, Centre for Social Responsibility in Mining, The University of Queensland</i>
10.55 – 11.15	<b>International Perspectives on Recycling and Industrial Ecology</b> – Prof Rod Eggert <i>Director, Division of Economics and Business, Colorado School of Mines, USA</i>
11.15 – 11.35	<b>Australian national waste policy and stewardship initiatives</b> – Bruce Edwards <i>Assistant Secretary, Waste Policy Branch, Department of the Environment</i>
11.35 – 12.35	Group work and report back to Forum (groups select one topic) <ul style="list-style-type: none"> <li>• How can Australia learn from global practices and initiatives?</li> <li>• What is the role of recycling and stewardship programs in modern economy?</li> </ul>
12.35 – 12.50	Developing a feasible exemplar project – Glen Corder
12.50 – 1.35	Lunch
Part II. Recycling sector in Australia: innovations or business as usual?	
1.35 – 1.55	<b>New business models in recycling and upcycling</b> – Anna Minns <i>General manager, TerraCycle</i>
1.55 – 2.15	<b>Industrial ecology and waste management at the state level</b> – Rod Clare <i>Office of Environment and Heritage, NSW Department of Premier and Cabinet</i>
2.15 – 2.35	<b>Metal scrap collection and recycling in NSW</b> – Luke Parker <i>CEO, Sell &amp; Parker</i>
2.35 – 3.35	Group work (groups select one topic)/ Panel discussion <ul style="list-style-type: none"> <li>• What are the practical responses to deliver industrial ecology at regional levels?</li> <li>• How can innovation drive better industrial ecology practices in Australia?</li> </ul>
3.35 – 4.00	Shaping the pathway to shift the resources paradigm – Glen Corder & Damien Giurco

# WORKSHOP FINDINGS

## SESSION 1. CIRCULAR ECONOMY AND NATIONAL INITIATIVES

**Questions: How can Australia learn from global practices and initiatives? What is the role of recycling and stewardship programs in modern economy?**

- Learning from other countries (structural transitions, we're 10 years behind Europe).
- Design for resource efficiency.
- Circular economy is about regenerative design, design for disassembly versus high functionality.
- Product design plus new models of ownership (leasing/renting).
- Get understanding of impact of Industrial Ecology on jobs.
- Local councils – facilitators but no technical expertise (need support?).
- Role for Councils to build momentum for community.
- Different waste types mean different approaches (industrial waste versus household waste).
- Look at specific industry:
  - Learn, don't reinvent the wheel.
  - Industry can be controlled by overseas "influence" (limit innovation).
  - Learn mistakes.
  - Learn social behaviour (designing new technology/products).
- Minimising waste to landfill – [national/state] indicators not always balanced.
- System perspective is essential and inevitable (systemic regulation is needed).
- Stimulus is better than regulation (though some push for co-regulation).
- National approach – make recycling profitable and business will take care of the rest.
- Be clear on the purpose of Wealth from Waste Cluster. Is it to convert liabilities into assets, or improve health, or resource security, or productivity plus prosperity? Is the objective cherry picking (select showcase examples) or transforming the market clearing price?

## SESSION 2. RECYCLING SECTOR IN AUSTRALIA

**Questions: What are the practical responses to deliver industrial ecology at regional levels? How can innovation drive better industrial ecology practices in Australia?**

- Business model development is key (not just product design).
- Don't focus on technical aspects, EU has done it, instead focus on innovative systems.
- Open innovation systems (signal of location and regional initiatives).
- Systems established and scale will provide the opportunities to capture value from smaller streams.

- Reward system for being part of the circular economy, including those designing products that are easier to recover + recycle (i.e. rewards for all participants in the supply chain).
- Where does competition come into play? We need to understand the open innovation system in the broader sense and the economic case (how do we keep a focus on opening out innovation systems rather than locking in?). Cooperation between competitors not a barrier.
- Can only change attitude by articulating problem matching with solution (don't speak of opportunity).
- Role of market signals – getting them right to drive behaviour/investment. How to demonstrate a commercial need? Site planning plus approvals. Financing. Logistics of material flow from household.
- Product stewardship: more than just financial incentives (profit motivation), issue of number of actors in the supply chain, issue of leadership, product design for disassembly.



**Anna Minns, TerraCycle, presenting at the Forum.**



**Panel discussion.**

# QUESTIONS AND SUGGESTIONS TO RESEARCH AGENDA (FROM PRESENTERS)

The presentations at the workshop provided invaluable insights into the topic from academic, government, and industry perspectives, also raised additional questions from the audience and helped to facilitate the following discussions. Some of the key messages, suggestions and recommendations for the research agenda, arising from the presentations (and captured by authors), are presented below (the list is not exclusive).

## **Saleem Ali (The University of Queensland)**

- Product design imperatives for transition to circular economy.
- Business models that can ensure sustainable livelihoods for communities.

## **Rod Eggert (Colorado School of Mines, USA)**

- The role of international/national/state regulation in achieving higher recycling rates.
- Subsidies for mining industry versus none for recycling industry in Australia.

## **Bruce Edwards (Department of the Environment)**

- Importance of national approach to exclude interstate waste move.
- There are no processing facilities for some metals in Australia. Shipping of metal scrap to overseas can always be a case, though it may also facilitate better processing overseas.

## **Anna Mins (Terracycle)**

- “More you separate – less you pay” (case study in British Columbia).
- Different collector groups for different waste streams (who is interested, has a capacity, volunteered).

## **Rod Clare (Office of Environment and Heritage, NSW)**

- Facilitation to establish contact and create credibility for potential IE projects is crucial (government involvement and support).
- Need to build the business case for IE through understanding the drivers and barriers as well as through regional innovation hubs, education and training plus standards and codes of practices.

## **Luke Parker (Sell & Parker)**

- Characterise “unrecovered stuff” (unprofitable/too complex/dangerous).
- Define profitability zone (marginal costs of recycling for distances and types of waste).
- What is the infrastructure need (gap) for each waste stream? A need for centrally planned approach? What is the waste state (how easy to recycle)?
- “Make recycling sustainably profitable”.
- We cannot influence products design (due to small domestic market), but can follow EU legislation
- What can change the economics (e.g. in 20 years)? E.g. scale and critical mass; product life time and leasing; focus on processes improvement (not equipment); new technologies can change marginal costs and/or extend resource base (feasible to recycle).
- Why to recycle (main purpose)? E.g. lack of landfill and resources; social expectations.

# FEEDBACK FROM PARTICIPANTS

A separate feedback form was used to collect participants' opinion about the success of the event, its format and findings, as well as recommendations for the next workshop.

- 93% of respondents recognised forum's presentations as excellent or very good.
- 86% of participants found table discussions being productive.
- 71% of people assessed the forum's findings as highly valuable and original.
- All respondents considered the workshop as a worthwhile experience that fully met (50%) or almost met (50%) their expectations.
- The participants expressed a very strong interest to be involved in the next workshop.

## **Selected responses (the most important ideas raised during the workshop)**

- "Collaboration + Innovation = Sustainable communities and competitive businesses".
- "Work out what is needed where:
  - central planning,
  - mapping resource,
  - national model, business driven, regional focus".

## **Main recommendation for the next workshop**

- Invitation only.
- Less questions to cover in table discussion. Focus on one outcome at a time!
- How can communities be involved in circular economy – what support infrastructure is needed?
- IE needs for domestic municipal waste. Focus in research for external opportunities.
- More examples of metal recycling.
- Short intro of everyone.
- Include topics related to industrial waste, not just regular waste.
- Scenario planning for Australian circular economy.

## CONCLUSION AND NEXT STEPS

The event was the first of two scheduled industrial ecology workshops for Program 1 in the Cluster. The main aim of the workshops is to bring together different stakeholders and share the experience on the existing state of recycling activities in Australia, and identify major barriers and opportunities to uptake best international approaches and achieve higher levels of metal recycling in Australia.

The main results from the first workshop show that:

- Product design is an imperative for the circular economy and efficient recycling; however there is a limited influence that Australia can make on imported products. The best option would be to closely follow other countries legislative requirements in this area, e.g. European Union.
- Business models are crucial for successful recycling activities. The main focus should be on innovative systems (and copying technologies from other countries).
- National approaches should create a basis for allowing recycling business to be profitable. The market signals have to drive behaviour and investment in the recycling and waste management sector. Stimulus is better than direct regulation (though co-regulation can be desirable in some cases). “Make recycling sustainably profitable”.
- There is a lack of data and understanding on lost opportunities (unrecovered materials). Additional investigations and mapping of above ground stocks, and material flows are needed.
- Different waste types mean different approaches. Focus on specific industry and its infrastructure needs/gaps for each waste stream.
- A characterisation of profitability zones (marginal costs of recycling for distances and types of waste) would provide a better understanding on how the national/state regulations influence the efficiency of recycling and may increase/decrease overall recycling rates.

The key findings above speak to the core aims of Program 1 in the Wealth from Waste Cluster. An important question that remains is how to effectively shift the resources paradigm towards the circular economy in the context of Australian recycling landscape. The next workshop will report on the progress of the research, framed by the key outcomes of this initial workshop. Participants will be asked to provide commentary and contribute input on the progress of the research to date. The timing of the second workshop is scheduled for quarter 3 2014.

# APPENDIX A. READING MATERIALS SENT TO WORKSHOP PARTICIPANTS

## A.1 Metal recycling for an export-oriented economy

From: Golev, A.; Corder, G. D. 2014. Global Systems for Industrial Ecology and Recycling of Metals in Australia. Draft Research Report. Centre for Social Responsibility in Mining, Sustainable Minerals Institute, The University of Queensland. Brisbane.

### Highlights

We estimated that:

- there is between five and six million tonnes of metal content in the waste streams in Australia a year,
- which could cover 60-70% of annual metal consumption within the country,
- with an estimated worth of more than A\$5 billion if the metals are fully recovered.

As a result, the estimated potential for “wealth from (metal) waste” is A\$2 billion a year.

The recycling or secondary production of metals helps to save significant amounts of energy required to produce metals from virgin ores, thus minimizing environmental impacts and supporting sustainable development through the efficient use of resources. The world demand for metals however is still mostly covered by primary production. In the export-oriented resources rich countries such as Australia, it is an ambiguous question how metal-recycling efforts can contribute to a greener economy allowing for continuing economic growth and preserving a country’s natural resources. The closed loop economy model actively promoted in the European Union, Japan, and other countries presupposes predominantly cyclical use of metals within the system. It is however economically impractical to limit the system to the national or regional borders, and it should be justified and achievable at the global scale. This means that some countries still may need to play the role of net providers of primary (mined) material resources. However, it should not undermine the need for recycling and reuse of materials within the domestic borders.

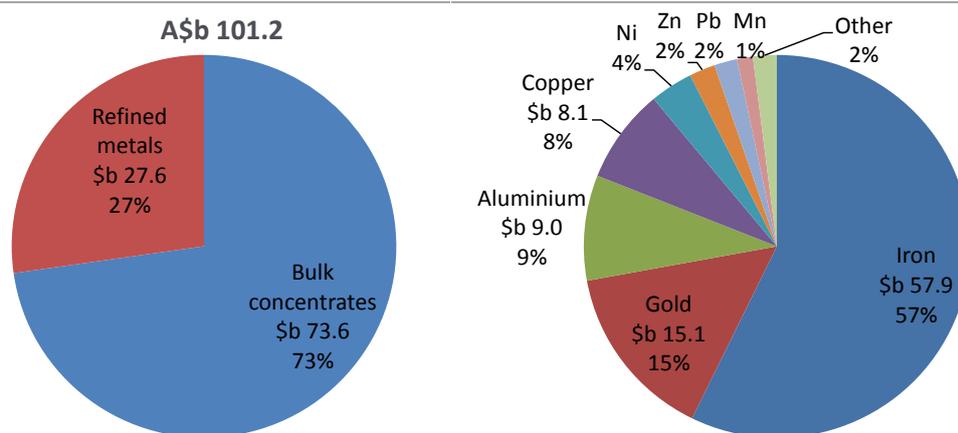


Figure 1. Australian metals export revenue in 2012/13. Source: BREE, 2013.

The Australian economy has relied on mining for successive generations. The abundance of natural resources and the relatively low population has predetermined the role of Australian economy on the global market as a resources supplier. Metals and metal concentrates currently deliver the country’s main export revenue (A\$101.2 in 2012/13), followed by energy resources such as coal, natural gas and uranium

(A\$b 67.4). More than 90% of minerals mined in Australia are directly exported; for metals and metal concentrates this figure is close to 98%. In 2012-13, Australia exported more than 300 million tonnes of metallic content. Some metals are primarily exported as concentrates (e.g. iron ore, alumina, copper, zinc, lead, manganese), while others in the form of refined metals (e.g. nickel, gold, silver) or chemicals (e.g. titanium dioxide pigment). Additionally, more than 2 million tonnes of scrap were also shipped overseas.

The statistics on domestic consumption of metals (including imported products) is not accurate worldwide. It is not officially estimated in Australia; however we have assumed that it is in the range of 300 to 400 kg per capita versus about 250 kg world average and about 400 kg in EU-27 countries and the USA (USGS, 2008, 2014). This gives a total metal consumption rate in Australia at about seven to nine million tonnes a year (2012/13), which is in agreement with the apparent metal consumption rate based on production and export-import flows (BREE, 2013).

Based on reports from UNEP and USGS we have estimated that the annual waste metal generation level could account for 60-70% of the current consumption (taking into account the average period of metal use within the economy, metal consumption and population growth over the last few decades). For Australia, this results in 200-250 kg per person or five to six million tonnes in total of metals in the waste streams a year. This figure is close to data derived from national waste reporting (DSEWPaC, 2012, 2014).

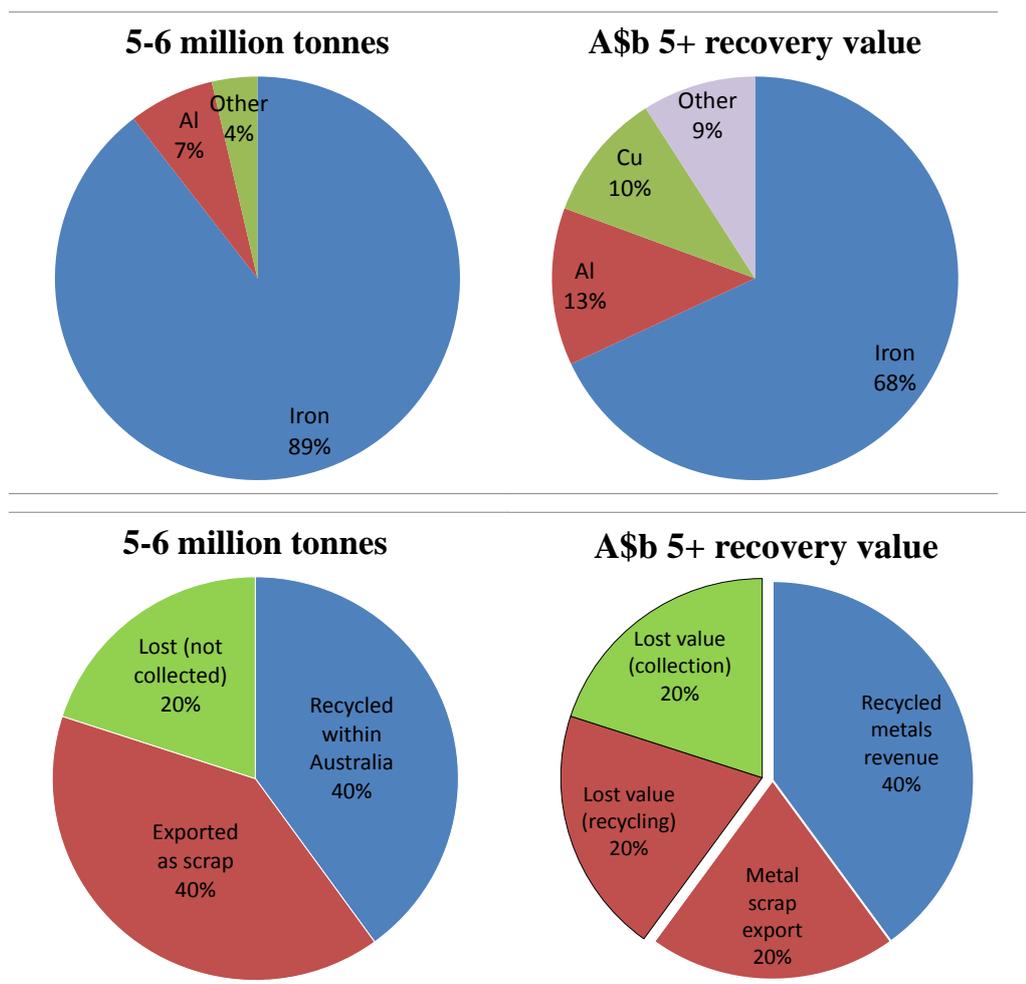
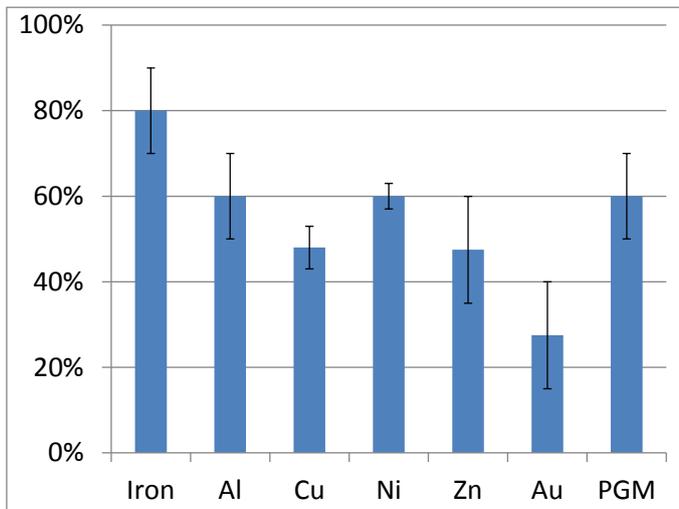


Figure 2 (a, b). Metals in waste streams in Australia (2012/13). Source: Authors estimation.



**Figure 3. World estimates for end-of-life recycling rates (EoL-RR). Source: UNEP, 2011.**

### References

- BREE, 2013. Resources and Energy Statistics 2013. Bureau of Resources and Energy Economics, Canberra, Australia. Available at: <http://www.bree.gov.au/publications/resources-and-energy-statistics> (accessed on 19 December 2013).
- DSEWPac, 2012. The Australian recycling sector. Net Balance for Department of Sustainability, Environment, Water, Population and Communities. Brulliard, C.; Cain, R.; Do, D.; Dornom, T.; Evans, K.; Lim, B.; Olsson, E.; Young, S.
- DSEWPac, 2014. Waste generation and resource recovery in Australia. Blue Environment Pty Ltd for Department of Sustainability, Environment, Water, Population and Communities. Randell, P.; Pickin, J.; Grant, B.
- UNEP, 2011. Recycling Rates of Metals - A Status Report. A Report of the Working Group on the Global Metal Flows to the International Resource Panel. Graedel, T.E.; Allwood, J.; Birat, J.-P.; Reck, B.K.; Sibley, S.F.; Sonnemann, G.; Buchert, M.; Hagelüken, C.
- USGS, 2008. The global flows of metals and minerals. U.S. Geological Survey Open-File Report 2008-1355. Rogich, D.G., Matos, G.R.
- USGS, 2014. Commodity Statistics and Information. U.S. Geological Survey. Available at: <http://minerals.usgs.gov/minerals> (accessed on 14 March 2014).

## A.2 The status of industrial ecology in Australia: barriers and enablers

From: Corder, G. D.; Golev, A.; Fyfe, J.; King, S. 2014. The Status of Industrial Ecology in Australia: Barriers and Enablers. *Resources*, 3(2): 340-361. Available online: <http://www.mdpi.com/journal/resources>.

Over the last 15 years, the concept of industrial ecology has been applied in Australia at different levels – from small to medium enterprise-focused waste exchange networks to heavy industrial areas – with varying degree of success. Undoubtedly, it is now a well-recognised approach to increase resource efficiency and minimise environmental impacts associated with industrial and consumer activities. The country's unique geographic location as a continent, with long distances between major cities and industrial centres in regional areas, being the major challenge, also shapes the opportunities to enhance the application of industrial ecology.

The history of applying the concept of industrial ecology in Australia is closely related to cleaner production techniques, eco-efficiency and waste management practices. The combined efforts of the state and federal government, industry associations, academic institutions and environmental organizations in mid-1990s resulted in the successful demonstration of these approaches to minimize environmental impacts arising from industrial activities within different sectors, and in recommending the development of national guidelines for companies based on this experience (Dames&Moore, 1997; Dempster et al., 1997; ANZECC, 1998). Further application and promotion of industrial ecology approaches has been attributed to several initiatives supported by the Australian government, such as Green Stamp Program, Centre for Sustainable Resource Processing, and others (van Beers, 2007; van Berkel, 2007).

More recently, the 2013 New South Wales (NSW) Government Waste and Resource Recovery Initiative has recognised the potential of industrial ecology by prioritising the establishment of four industrial ecology networks as part of its Business Recycling Program (NSW Govt, 2013). This industrial ecology initiative is driven from the success of the NSW Sustainability Advantage program, which supports businesses to reduce risk and cost by reducing their environmental impact. This includes identifying and implementing industrial symbiosis opportunities. The program has resulted in 530 businesses reducing costs by \$75 million a year due to reductions of energy, water, waste and raw materials (NSW Govt, 2013). The support of industrial ecology or symbiosis within government marks a strategic turning point in waste management, recognizing waste as a potential resource. It supports both environmental goals to reduce waste to landfill and industry goals to improve resource efficiency and competitiveness.

Most of the Australian examples of industrial ecology initiatives were implemented with the local and state government support (in different forms), while there are very few projects that have been developed and have succeeded solely on the basis of industry interest and funding. With a focus on technical feasibility and establishing inter-industry collaboration in the existing cases, there are still other barriers preventing waste and by-product exchanges from happening. The economic driver usually predetermines the investigation for waste reuse options, with environmental regulation being another important factor to stimulate or prevent any interest in establishing synergy connections.

Answers to the following questions could greatly help enhancing industrial ecology applications in Australia:

- How would better information availability, including detailed reporting on economic and environmental achievements from implementing synergy projects assist uptake of industrial ecology applications?
- Would recognition and active promotion of national champions in industrial ecology, for advertising and sharing best practices and experience increase uptake?

- What further improvements in the environmental regulation could contribute and encourage the adoption of best-known technologies and waste reuse projects?
- Would defining of long term targets for waste reuse and recycling, supported by the development of specific projects drive better industrial ecology outcomes?
- Could sharing of common failures and successful factors between local and State government efforts across Australia expand the collective knowledge base and increase support and acceptance of industrial ecology applications?

## References

Australian and New Zealand Environment and Conservation Council (ANZECC). Towards Sustainability: Achieving Cleaner Production in Australia: Report. Environment Australia: Hobart, Australia, 1999. Available online: <http://www.environment.gov.au/archive/settlements/industry/corporate/eecp/publications/nscp.html> (accessed on 14 March 2014).

Dames & Moore Environment Australia. Cleaner Production Manual: Environment & Business Profiting from Cleaner Production; Environment Australia: Canberra, Australia, 1997.

Dempster, P.; Jubb, C.; Nagy, L.; Stacey, N.; Versteegen, A.; Lawrence, D. A Benchmark of Current Cleaner Production Practices; Environment Australia: Aquatech, Australia, 1997.

NSW Government. Waste Less, Recycle More—A Five-Year \$465.7 Million Waste and Resource Recovery Initiative. Available online: <http://www.environment.nsw.gov.au/resources/waste/130050WLRM.pdf> (accessed on 19 November 2013).

Van Beers, D.; Corder, G.; Bossilkov, A.; van Berkel, R. Industrial symbiosis in the Australian minerals industry—The cases of Kwinana and Gladstone. *J. Ind. Ecol.* 2007, 11, 55–72.

Van Berkel, R. Cleaner production and eco-efficiency initiatives in western Australia 1996–2004. *J. Clean. Prod.* 2007, 15, 741–755.

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