CITATION

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1. INTRODUCTION

While forms of recycling of goods and materials have always existed, there are new imperatives in affluent countries such as Australia to consider the role of metals recycling or urban mining. This is driven by two main concerns, 1) the need to reduce environmental costs associated with sourcing metals from virgin mining (UNEP 2013), and 2) concerns about future scarcity of specific metals used in manufacturing due to either resource depletion or supply risks linked to global trade dependencies (Graedel et al 2011, Graedel et al. 2013, UNEP 2013). In policy terms, this means a shift from a “logic of hazard” to a “logic of resource” (Kama 2014) that requires reframing what has been regarded as waste management as resource recovery.

In Australia, incentives for scaling up recycling are now coming from government policy (e.g. state-based landfill levies to deter dumping, Australia’s National Waste Policy which supports product stewardship take back schemes), from business corporate social responsibility initiatives, and from a wide range of community sector organisations seeking opportunities for employment generation and training. These developments are all taking place against a wider context of increasing circulation of used goods and materials globally, and within the Asian region in particular. Growing demand for inexpensive commodities in China and India is driving new flows of used commodities from around the world to feed emerging recycling-based industries in the Asia-Pacific region (Kaplinsky and Farooki 2010, Schandl and West 2012, Kirby and Lora-Wainwright 2015).

The research presented here forms one of a number of projects being undertaken as part of ‘Wealth from Waste’, a multi-university CSIRO Flagship Cluster research program that explores the feasibility of developing a capacity for advanced metals recycling in Australia. Within the Wealth from Waste research program the specific role of this research is to provide an appraisal of existing collection systems, including a characterisation of the range of types of organisations involved as well as a more focused assessment of organisations and collection systems currently responsible for the bulk of the material flows. The focus is specifically on collection systems and reprocessing for scrap metal, and communications electronics from Australian cities. While bulk scrap, especially ferrous metals, is relatively low in market value, it is generated in large enough quantities to be economically significant. By contrast, electronic waste contains high value materials (e.g. gold, rare earth metals such as indium) but in small quantities (UNEP 2013). In both cases the resource is widely distributed mainly in Australia’s large cities. However, the bulky character of scrap metal compared with the smaller units that characterise used electronics mean that different logistical challenges arise requiring different collection approaches, equipment and facilities.

The overall aim of the research presented here is to broaden understanding of the range of organisations involved in collection of these materials and of the factors that affect their operations. More specific aims are as follows:

1. to identify and characterise the range of organisations involved in the collection and reprocessing of scrap metal, and used electronics (including mobile phones, handheld batteries and computers and televisions) from Australian cities
2. to identify incentives and disincentives for involvement of different types of organisations in collection systems
3. to identify factors that most strongly influence the effectiveness of collection systems, including the role of a wide range of relevant legislative schemes and regulatory agencies
4. to identify and characterise the spatial and logistical dimensions of systems for collection and reprocessing of used electronics and scrap metal in Australia
1.1 BACKGROUND: METALS RECYCLING IN AUSTRALIA

In models for material flows used in industrial ecology (IE), collection is often depicted as a simple black box with little attempt to elaborate on factors that influence collection rates and quantities or the various processes involved. However, many factors can influence the capacity of organisations to collect valuable resources from used products and these include the broader economic environment, the regulatory environment and wider social endorsement of recycling.

Scrap metal recycling is a well-established industry in Australia responsible for recycling significant quantities of mainly ferrous metals both within Australia and through export to other countries. It is characterised by a few large companies with steel shredding facilities, including Sims Metals, a transnational business, and large state-based businesses such as Sell and Parker (NSW) and Norstar (VIC). OneSteel operates the steel smelters in Melbourne and Sydney that facilitate domestic recycling and also collects and shreds scrap metal in its own right. Feeding into these large businesses is a plethora of smaller collecting organisations that transport and sell scrap metal to them. Some of these smaller businesses also export scrap directly. A key concern for Wealth from Waste research is the need to understand the factors that influence whether scrap metal is recycled locally or exported.

Electronic waste has only recently been targeted for recycling in Australia, prompted by rapid growth in electronic consumer products with short periods of usage, which has created a vast new hazardous waste stream, along with possible resource security issues. Various initiatives have emerged from government and industry, including the Australian Government’s National Computers and Television Recycling Scheme (DSEWPaC 2011), as well as state government landfill levies and regulation on disposal of hazardous waste to landfill (Gumley 2014). The Australian Mobile Telecommunications Association (AMTA) implemented a voluntary industry product stewardship take back scheme for mobile phones in the early 2000s – the Mobile Muster scheme - and research conducted to monitor its effectiveness over time provides the most detailed information to date about consumer behaviour available for electronic devices in Australia. While community sector organisations (including charities and social enterprises) have collected used electronics for resale and reuse for some years, these more recent developments have been associated with rapid change in the landscape of organisations involved in collecting and reprocessing of used goods and the proliferation of new kinds of commercial businesses operating across different parts of the supply chain for recycled electronics. There is potential for both collaborative and competitive relationships to emerge between community sector organisations and commercial businesses.

Many materials that were once considered to be hazardous waste have increasingly become commodities subjected to international trade. While Australia’s endorsement of the Basel Convention on Transboundary Movement of Hazardous Wastes prohibits exports of electronic waste outside of approved channels, it is clear that a wide range of second-hand electronics are now exported and marked for resale rather than disassembly for recycling. This phenomenon has been documented in many other countries also signatory to the Basel Convention and has led some commentators to ask whether we have now moved into a “post-Basel world” (Lepawsky 2015). This apparently illegal trade can be difficult to distinguish from genuine trade in second-hand electronic goods, although most Australian states require commercial traders to hold a second-hand dealer’s licence.

The following information gaps have been identified and are specifically targeted in this research so as to develop a more sophisticated understanding that can then inform new initiatives to improve the effectiveness of existing collection systems:
• Incentives and disincentives for collection, reprocessing and recycling generally
• Incentives and disincentives for reprocessing within Australia versus export to other countries for reprocessing
• The character of skills and labour involved in collection, reprocessing and recycling
• The character of interactions between the community sector and the fully commercial sector
• The role of regulation – not just recent product stewardship legislation but a wide range of areas of regulation that potentially impact on collection, reprocessing and recycling
• Influence of the broader economic environment on collection systems e.g. fluctuations in levels of economic activity domestically and globally, fluctuations in the prices of metals, fluctuations in the exchange rate for the Australian dollar
• Influence of broader social concerns around waste, recycling and sustainability

The following chapter explains the approach and methods used for the study, detailing the selection of organisations and explaining the approach to interviews. This is followed by two separate chapters dealing with scrap metal recycling and e-waste recycling respectively. Within each of these chapters, an effort is made to characterise the types of organisations involved in that part of the commodity chain between disposal by a first owner, and accumulation at a centralised location for sorting, reprocessing or on-selling. While an effort is made to understand factors that influence the portion of material processed in Australia versus that exported for processing overseas, following materials after they leave Australia is beyond the scope of the Wealth from Waste research.

Because the scrap metal and e-waste recycling industries are so different in character and are affected by different regulatory regimes, each chapter provides an industry-specific overview of the regulatory framework for the management of each category in Australia, with particular attention to barriers and incentives affecting different types of organisations in each industry and concludes with a discussion of possible interventions and propositions that could improve the rate of collection and facilitate reuse or reprocessing within Australia.
2. APPROACH AND METHODS

As with the Wealth from Waste research program more generally, this study is framed by industrial ecology (IE) approaches to material flow analysis (MFA). While other WfW research has examined the flows of metals into and out of Australia (Golev and Corder 2014), the focus here is on understanding the shape of flows within Australia, the organisations that facilitate them, and the factors that affect the pathways taken to landfill, domestic reuse, recycling or export. This is a level of detail not usually found in IE approaches but one that is important for understanding barriers and incentives that operate domestically, including spatial and logistical dimensions. Ultimately, it will result in the development of more sophisticated approaches to the modelling of material flows that are able to factor in the likely effects of future policy or regulation and fluctuations in the broader economic environment.

A resource geographies approach, developed for understanding virgin resources, is drawn on in order to characterise commodity chains and networks (Bridge 2008, 2009). It provides useful tools for understanding the factors at play, including economic, regulatory and social factors, as collected materials move through different stages in the commodity chain for recycled metals. Because of the significant role played by the charity sector and various forms of social enterprise in the collection and reprocessing of used goods and materials, the analysis also draws on ideas of diverse economies that are able to take account of a wider range of social values in addition to more conventional understandings of economic value in monetary terms (Gibson-Graham 2006).

The following research questions provided the focus for the study:

- What types of organisations are involved in the collection and reprocessing of scrap metal, mobile phones, handheld batteries and computers and televisions from Australian cities, and how do they interact with commodity chains for recycled metals?
- What are the more significant incentives and disincentives influencing the involvement of different types of organisations in collection systems, and what are the underlying drivers of change?
- What factors most strongly influence the effectiveness of collection systems?
- What are the spatial and logistical characteristics of systems for collection and reprocessing of used electronics, handheld batteries and scrap metal in Australia?
- What is the role of regulation in promoting better collection, recycling and reuse of materials? Is the current policy preference for soft regulation models appropriate in this sector? Are there better models than those currently applied in Australia?
- What data is recorded by organisations about their collecting and reprocessing activities?

Interviews were conducted with representatives from 47 interviews covering the collection, transport, sorting and reprocessing of scrap metal and used electronics, as well as organisations responsible for regulating these activities, in order to understand 1) the characteristics, key stages and geographical dimensions of the commodity chain connecting discarded goods and materials with various forms of reuse or recycling, 2) the role of different actors and organisations along the commodity chain, 3) the character of these organisations, and 4) the various barriers and incentives affecting their activities at different stages of the commodity chain. A key concern was to identify any factors that influence whether or not reuse or recycling will occur at all and, if so, whether that reuse or recycling is more likely to take place locally or through export to other countries.
2.1 DATABASE OF ORGANISATIONS

Two main strategies were employed to identify organisations involved in the collection of scrap metal and electronic waste: (1) a desktop search using keywords such as ‘scrap metal’, ‘e-waste’ ‘electronic waste’ and ‘recycling’ and through searching lists of member organizations for important associations, such as the Australian Metal Recycling Industry Association (AMRIA) and the Waste Management Association of Australia (WMAA), and (2) a snowballing approach based on contacts obtained through professional networks maintained by the various university research groups involved in Wealth from Waste research, including the list of organisations that attended the formal launch of the Wealth from Waste research program in Sydney in February 2014, and through project colleagues who also had existing contacts, recommendations from interviewees themselves and from attending conferences.

Contacts and information not readily available on websites was obtained from directly calling organisations and from the IBISWorld database. We compiled information about collecting organisations into a database, systematically recording the following information where available:

- Contact details (e.g. names, email addresses, phone numbers, websites)
- Location/s
- Business information (e.g. profits, number of employees)
- Activities they participated in
- Handled materials
- Facilities and equipment owned
- Collaborators, including Industry Affiliations
- Main clients
- Main competitors

While this exercise was by no means definitive, it provided a valuable perspective on the range and types of organisations and informed the selection of organisations to contact for semi-structured interviews. Please note that the names and contact details of interview participants are treated as confidential in line with obligations under our Ethics approval.

2.2 INTERVIEWS AND DATA COLLECTION

The main criterion for the selection of organisations for interviews was the need to cover a range of organisation types both across and within categories. Factors taken into account include the activities organisations engaged in, and the size and location of organisations. We focused on organisations operating in Sydney and Melbourne. The broader principles guiding the selection were to capture:

- The diversity of organisation types, from sole operators to transnational corporations, spanning different parts of the commodity chain for recycled metals and taking in large and small community organisations, commercial businesses and everything in between
- The organisations responsible for the largest volumes of materials for recycling
- The perspectives of industry associations on the concerns of the organisations they represent
- The perspectives of government agencies responsible for either regulating or encouraging the emerging recycling industry.
Prospective interviewees were contacted either by phone or email, and were sent an Explanatory Statement outlining the research project and information about participating in it. If they agreed to participate, an Interview Question Guide was sent to give them an indication of the line of questions that would be covered. The questions were arranged under these topics:

- Characterizing organisations involved in collections systems
- Incentives and disincentives affecting involvement in collections systems
- Factors affecting the effectiveness of collections systems
- Spatial and logistical characteristics of collections systems
- Information and data collected by collections systems

Whilst these were broad lines of questioning that were covered, separate interview question guides were created to cater to specific sectors or even specific organisations which occupied unique positions in collection systems. The possibility of asking follow-up questions was also raised, with a particular view to subsequently obtaining quantitative data from select organisations which may be used in mapping and scenario modelling. Appendices A and B contain the Interview Question Guides that informed the semi-structured interviews, along with the Explanatory Statement provided to all interviewees. The research was approved by the Monash University Human Research Ethics Committee, CF14/1787 - 2014000903 and CF15/632 - 2015000288.

All 47 interviews were fully transcribed and imported into NVivo 10 software for thematic coding. Initial schematic diagrams were produced for several collecting/reprocessing organisations to represent where they sit in the commodity chain for recycled metals and this facilitated the characterisation of different types of organisations. Two interviews conducted by UTS Business School (P3) were also drawn upon.

Finally, insights were also obtained from submissions made to relevant government initiatives, most notably the Australian Government’s “Operational Review of the National Television and Computer Recycling Scheme” and the Victorian Government’s Discussion Paper “Managing e-waste in Victoria: Starting the Conversation”. Reviewing these submissions provided valuable perspectives from a range of organisations into how they viewed existing and proposed government initiatives and how these affected their ability to be participate in collections systems.

### 2.3 TYPES OF ORGANISATIONS AND POSITIONING IN COMMODITY CHAINS FOR RECYCLED METALS

Organisations interviewed were divided into the following groups:

- Industry Associations/Experts
- Government Agencies
- Commercial Business – general waste management
- Commercial Business – scrap metal
- Commercial business – construction
- Commercial business – demolition
- Commercial Business – e-waste collection
- Commercial Business – e-waste processing
- Commercial Business – logistics
- Commercial Business – consulting
- Social Enterprises
- Academics
In this report we refer to all not-for-profit community sector organisations as ‘social enterprises’ due to the fact that all seek to make some kind of financial return or at least break even financially from their activities. These organisations are distinct from commercial businesses in that their overarching purpose is the promotion of social wellbeing objectives rather than generation of profits for owners or shareholders (Barraket and Collyer 2010). They include large and small organisations, many of which have developed around employment training and some of which have links to churches.

Commercial businesses also take many forms and our initial categorisation is based on types of materials handled and whether they mainly collect or process materials, or if they are primarily involved with logistics and brokering of business-to-business relations. Key industry associations represent the concerns of different types of organisations and play an important role in lobbying government on policy matters affecting their members, and these interviews were valuable for gaining a broader perspective on the range of issues and concerns across their membership. Relevant government agencies include State Government Environmental Protection Authorities (EPAs) in their role as pollution and waste control ‘watchdogs’ as well as various other government agencies involved in promoting business innovation and sustainability.
3. SCRAP METALS

3.1 THE COMMODITY CHAIN FOR SCRAP METALS

This section, whilst discussing collections systems for scrap metals, will draw primarily upon research and insights obtained in relation to metals in buildings; the construction industries are the largest sector of Australia’s scrap metal recycling industry, comprising 38.3% by total revenue in 2012-13 (IBISWorld 2013). To understand the factors affecting the viability of the scrap metal recycling industry within Australia, it is useful to conceive the industry as comprising three related stages:

1. **Sourcing** – This involves the collection of scrap metal from various sources, such as waste transfer stations and demolition and construction companies, and subsequent transport to recycling and processing centres.

2. **Processing** – This involves aggregation, storage, reprocessing and transporting of scrap metals to other downstream processing sites such as smelters to manufacture new products.

3. **Procuring** – This involves procuring metal products for buildings, which can be characterized in several ways (domestic/foreign; recycled/non-recycled; prefabricated etc.).

The scrap metal recycling industry is market-driven on a global scale (IBISWorld 2013). Additionally, it is more streamlined with a smaller range of actors compared to electronic waste, and therefore these stages are particular to the scrap metal recycling industry. The following sections explore the various forces and factors which affect these three activities. Figure 1 below summarizes the commodity chain for metals in Australian buildings.

**FIGURE 1:** The commodity chain for metals in Australian buildings.
3.2 TYPES OF ORGANISATIONS AND POSITIONING IN COMMODITY CHAINS FOR SCRAP METAL

The scrap metal recycling industry, with a focus on metals in buildings, involves the following types of actors, and the specific organisations for each type are tabulated in Table 1:

- **Scrap metal dealers/recyclers**, which collect, buy and/or process scrap and sell to smelters domestically or overseas for further processing
- **Construction companies**, which use metal products in buildings, and may also provide scrap to recyclers generated from on-site activities
- **Demolition companies**, which sell scrap to recyclers, and may undertake some exporting
- **Waste management companies**, which provide waste removal services for businesses and households (including bulk bins)
- **Logistics companies**, which export scrap to overseas markets
- **Smelters**, which reprocess scrap to manufacture new products
- **Industry associations/experts**, which represent or possess broad-level perspectives on industries

**TABLE 1.** Organisations interviewed in relation to scrap metal recycling

<table>
<thead>
<tr>
<th>CATEGORIES</th>
<th>NOTES</th>
<th>ORGANISATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry Associations/Experts</td>
<td>All from the construction industries</td>
<td>prefabAUS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Construction Edge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ACOR</td>
</tr>
<tr>
<td>Commercial business – scrap metal</td>
<td>Includes businesses involved in recycling and smelting</td>
<td>Norstar (2 interviews)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sell &amp; Parker</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OneSteel</td>
</tr>
<tr>
<td>Commercial business – construction</td>
<td>This is a broad category that includes various actors involved in the decision-making behind metals in building construction. Examples including construction companies, architecture firms and quantity surveyors</td>
<td>Leighton Contractors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Billard Leece Partnership (BLP)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Donald Cant Watts Corke (DCWC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arkit</td>
</tr>
<tr>
<td>Commercial business – demolition</td>
<td>Primarily businesses specialising in taking down commercial and industrial buildings (as opposed to residential houses)</td>
<td>City Circle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ausdecom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delta Group</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guilfoyle</td>
</tr>
<tr>
<td>Commercial business – general waste management</td>
<td></td>
<td>Hanson Landfill</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WM Waste Management</td>
</tr>
<tr>
<td>Commercial business – logistics</td>
<td>International shipping companies</td>
<td>Seaway</td>
</tr>
<tr>
<td>Academia</td>
<td>Structural Engineers</td>
<td>Monash University</td>
</tr>
</tbody>
</table>
3.3 FACTORS AFFECTING METAL RECYCLING AND USE IN AUSTRALIA

This section will focus on factors, such as barriers and incentives, which affect the three stages in the commodity chain for scrap metal that were explained above. The factors for each stage can be divided into two broad categories:

- **Market and economic factors**, which generally involve cost considerations about when and where to buy and sell materials, along with labour, logistics, transport and disposal costs
- **Legislative and regulatory factors**, which generally impose restrictions on the disposal, procurement, transport and processing of materials at local, state, national or international scales

Understanding the factors which affect activities within each of the three stages will facilitate the identification of interventions that may modify the commodity chain and promote ways for Australia to transition towards a circular economy for metals. Insights about these factors were obtained from interviews and from literature reviews.

3.3.1 SOURCING SCRAP METAL

Manufacturing (such as the automotive industry), building demolition (especially of industrial and commercial buildings), car wreckers and waste transfer stations are significant sources of scrap metal for recycling. Construction companies may also supply metals collected and discarded during on-site activities (IBISWorld 2013). Scrap metal recycling in Australia is dominated by a few large scrap metal dealers and recyclers who handle the bulk of the supply (IBISWorld 2013), which is generally divided into ferrous (containing iron, such as steel) and non-ferrous (such as copper and zinc) metal. Additionally, there are numerous smaller second-tier scrap metal dealers, who often sell their scrap to these larger businesses.

Metals in buildings, especially industrial and commercial buildings, contain significant stocks of metals for future recycling. When these stocks will become available for recycling depends on demolition rates, which in turn depend on the type of building. According to the interviews with representatives from the demolition industry, the lifespans of buildings currently being taken down are around 40 to 60 years old. For industrial buildings, feasibility studies are conducted to assess the costs of running and maintaining existing plants compared to relocating elsewhere, and currently the decline of key manufacturing industries in Australia, such as the automotive industry, has meant that factories and plants are being closed down in favour of establishing overseas plants. For commercial buildings, demolition is dependent more on the developer, who decides when to demolish buildings to make way for new construction developments. Concrete-based buildings containing reinforced steel (reo), which are currently the preferred building structure, especially in multi-residential buildings, are generally built to last 50 years, and comprise around 10% steel by weight according to interview participants. According to one industry expert the current economic environment has made increased construction more conducive to the construction of new buildings, rather than refurbishment, leading to higher demolition rates and lifespans as low as 30 years. However, given that demolition rates, in their close alignment with broader economic conditions, are cyclical, it is likely that a return to longer lifespans will eventuate.

Some categories of buildings, on the other hand, are not as affected by these broader economic conditions because their purpose and functionality is prioritized over profit; examples include hospitals and airports. In these cases, renovations and retrofitting certain parts of the building will be favoured over demolition, leading to generally longer lifespans.

There was consensus amongst interviewed representatives from the demolition industry that most, if not all, of the metals in buildings are now extracted, separated and sold to be recycled at end-of-life. The lack
of markets and concerns about structural integrity around reused materials has led to recycling becoming the de facto pathway for metals in buildings. Several factors have contributed to these high recycling rates. Considerable improvements in technology for separation of metals from demolition waste have been made over the past few decades, which have reduced labour costs, alleviated safety concerns and increased overall efficiency.

But perhaps most significant are weight-based landfill levies, implemented by several state EPAs and managed by either local government or private enterprise. In Victoria, landfill operators must pay a levy for each tonne of waste deposited at their premises pursuant to the Environment Protection (Industrial Waste Resource) Regulations, 2009. The levy is passed on to households and businesses that deposit waste at landfill sites, providing a strong price signal to discourage large quantities of waste being sent to landfills. The building demolition and construction sectors, which handle very large quantities of waste, are acutely affected by the landfill levy, and consequently they have identified alternative outlets for valuable resources that can be easily separated from the waste stream, such as scrap metal.

The rate of landfill levies (aka waste levies) varies widely across Australian States and Territories and the rates may also vary significantly between urban local government areas and more remote rural areas, where many landfill sites are unregulated. The following Table shows the current rates for landfill levies across Australia.

<table>
<thead>
<tr>
<th>STATE/TERRITORY and RELEVANT LEGISLATION</th>
<th>METROPOLITAN AREAS</th>
<th>NON-METROPOLITAN/RURAL AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Victoria</td>
<td>$58.91 per tonne</td>
<td>$29.52 (Municipal waste)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$51.63 (Industrial waste)</td>
</tr>
<tr>
<td>New South Wales</td>
<td>$133.10 per tonne</td>
<td>$76.70</td>
</tr>
<tr>
<td></td>
<td>($66.60 per tonne for shredder floc)</td>
<td>($38.40 for shredder floc)</td>
</tr>
<tr>
<td>Queensland</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>Tasmania</td>
<td>$88 per tonne from 1 Jan 2015 (Hobart CC).</td>
<td></td>
</tr>
<tr>
<td>South Australia</td>
<td>$57 per tonne</td>
<td>$28.50 per tonne</td>
</tr>
<tr>
<td>Western Australia</td>
<td>$40 per tonne (Inert waste)</td>
<td>$55 per tonne (Putrescible waste)</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>Australian Capital Territory</td>
<td>Charges and fees set at landfills, but not specifically levies</td>
<td></td>
</tr>
</tbody>
</table>

However, to some extent landfill levies also affect scrap metal dealers and recyclers by undercutting their financial bottom line. Sorting and separation inevitably produces some waste, and the levy impost to dispose of this waste at landfill detracts from what they can spend to buy scrap metal.

More broadly, the scrap metal recycling industry is linked to the mining industry through commodity prices and supply volumes are affected by the strength of the economy, which can stimulate increased disposal and buying rates (IBISWorld 2013). Commodity prices, along with labour and logistics, need to be factored into cost considerations, and may limit the volumes of metals that can be retrieved and sourced. For scrap metal dealers, difficult economic periods (for example, as experienced during the Global Financial Crisis) can negatively impact supply prospects because increased transport and fuel costs, along with low market...
prices for scrap metal, can limit the distances that sellers are willing to travel to drop off scrap or for mobile balers operated by dealers and recyclers to pick up material. Subsequently, the radius of viable sources is determined by these costs and broader economic circumstances. In these cases, stockpiling is a common practice until prices are favourable again to sell to recyclers.

### 3.3.2 PROCESSING SCRAP METAL

Once scrap metal is sourced and collected, processing and recycling into new products can take place in Australia or overseas, and the factors affecting decision-making at this stage are predominantly market-based and driven at a global scale (IBISWorld 2013).

With respect to **non-ferrous metals**, almost all processing and recycling takes place overseas. Taking into account labour for sorting and separation, energy and environmental costs, and economies of scale, recycling non-ferrous metals in Australia is a prohibitively expensive undertaking. Consequently, most of these unprocessed materials are exported overseas by either scrap metal dealers directly or through logistics firms, a proportion of which are overseas-based companies with operations in Australia.

With respect to **ferrous metals**, the key factors which affect whether they are recycled locally or exported overseas are demand, commodity prices, labour and transport (IBISWorld 2013). Scrap will be sent to recyclers to be shredded into sellable graded materials, which may then be processed further locally or sent overseas. There are a few domestic smelters, but the decline in Australian-based manufacturing, along with the relatively small size of the Australian market, has reduced demand and made it financially unviable for scrap metal dealers and recyclers to rely on domestic smelters to buy all their stock. They will then resort to exporting to markets abroad to remain profitable, such as in China and Thailand, and it has been estimated that exports accounted for around 47.7% of total industry revenue for 2012-13, an increase from 42.3% in 2007-08 (IBISWorld 2013). According to the interviews, this is impacted by several factors including:

- competition with virgin mined ore products, which may necessitate having to find more exotic markets in order to remain competitive,
- fragmentation and diversification of international markets, which has created more prospective buyers,
- volatile transport costs, which affect how far scrap can be sent and which markets are viable at any given time,
- price undercutting by illegal operators, who use the cash economy and scrap metal sales for money laundering.

Smaller recyclers who operate their own infrastructure often export unprocessed scrap by compacting them into bales, therefore bypassing domestic shredders, recyclers and smelters altogether. Such an option is appealing because it requires less labour and time; overseas shredder operators generally have cheaper labour and lower waste disposal costs. This consequently reduces scrap supplies for domestic recyclers, and also acts as another source of competition for recyclers who also export to overseas markets (although recyclers perform an additional processing step before exporting their product).

With respect to regulatory requirements, exporting scrap metal to overseas markets falls under the purview of the 1989 *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal*, which commits participating nations to reduce the production of hazardous waste and to restrict its transboundary movements. The Basel Convention has 180 participating nations, including Australia. The Australian Government enacted the *Hazardous Waste (Regulation of Exports and Imports) Act 1989* (Cth) to implement its obligations under the Basel Convention, as well as guidelines for transfer of hazardous waste between States and Territories (NEPC, 2010). However, despite these international
obligations, sizeable volumes of scrap metal are illegally traded and exported, manifesting in a ‘shadow price’ that undermines the profits of legitimate scrap metal businesses.

In part, state landfill levies on waste disposal have contributed to the export of unprocessed scrap metal for recycling overseas. By incentivizing more separation and recycling at waste transfer stations, landfills and building sites to minimize the waste sent to landfill, the costs of domestic processing through labour have increased, inadvertently encouraging exporting. Overall, the export of scrap metal for recycling overseas will continue to be necessary for domestic dealers and recyclers because of a lack of recycling infrastructure in Australia (for non-ferrous metal) and the larger scope and breadth of demand and markets overseas.

3.3.3 PROCUREMENT METAL

Once sent to domestic or overseas processing facilities, scrap metal may be recycled and sold in new products. The construction and manufacturing industries are significant drivers of the demand for recycled metal products in Australia. However, the ongoing decline of the manufacturing base in Australia has caused lower local demand for most metals, including recycled metals, and as such demand will continue to be driven predominantly by international markets and local construction. Therefore, the following discussion will focus on the factors affecting demand in the construction sector.

The Uniform Building Code of Australia (‘BCA’) was introduced in 1997 to replace eight separate construction codes in the various States and Territories and later incorporated into a National Construction Code (NCC) that provides the minimum necessary requirements for safety, health, amenity and sustainability in the design and construction of new buildings (and new building work in existing buildings) throughout Australia (Australian Building Codes Board, 2015a). The NCC Performance Requirements set the minimum performance standards that buildings, building elements, and plumbing and drainage systems must meet. There are two product certification schemes which the ABCB owns and jointly manages to provide a nationally consistent quality of materials and products; the voluntary ‘CodeMark’ building product certification scheme and the mandatory ‘WaterMark’ plumbing and drainage product certification scheme (ABCB, 2015b). Through these certification schemes the BCAs can exert considerable influence on the type and quality of metals used in construction.

In interviews it was recognized that Australian standards for steel, as stipulated in the BCA (Australian Building Codes 2009), could be more stringent relative to some overseas standards (such as those in China and other Asian countries), and in some cases, this could deter or even prohibit importing recycled products from these markets. For example, generally higher quality products are required for structural steel as compared to steel used in reinforced concrete. In these instances, products will need to be procured from Australian sources to ensure quality standards are met, at possibly more expensive prices. According to one interviewee from the construction industry, standards have increasingly become a concern in the last five to eight years because of the widespread availability of less expensive overseas products. However, a structural engineer who was interviewed commented that some steel standards, which the BCA makes references to, have not been updated in at least two decades, and there is currently discussion about updating these standards.

There are also opportunities for clients of building and construction companies to specifically seek out more sustainably produced, recycled metal products through procurement policies, as long as quality standards are satisfied. However, these are not enforced via regulation.

In 2009, the Commonwealth Government released a National Waste Policy (NWP). This policy recognised the need for “holistic approaches which address market, regulatory and governance failures, duplications and inconsistencies” whereby “waste streams are managed as a resource” (Australian Government, 2009). Recognising a shared responsibility for reducing the environmental, health and safety footprint of
manufactured goods and materials across the whole manufacture-supply-consumption-end of life chain, Strategy 2 of the National Waste Policy provides:

All governments as significant procurers of goods, services and infrastructure, will embody and promote sustainable procurement principles and practices within their own operations and delivery of programs and services to facilitate certainty in the market.

A Sustainable Procurement Guide was released in 2013 which mandates the use of Commonwealth Procurement Rules for procuring officials of certain Financial Management Agencies and other Commonwealth Authorities (Australian Government 2013). However, these procurement rules seem to focus upon consumable goods or services rather than expenditure upon capital assets like buildings.

In Victoria, procurement requirements also serve more as guidelines than stipulations. The Department of Treasury and Finance has established the Efficient Government Buildings program which applies an Energy Performance Contracting process to identify and install cost-effective energy and water efficiency solutions such as lighting upgrades and controls, heating and cooling efficiency improvements, building automation, water conservation measures and on-site electricity generation. However, it does not seem to encompass strategies to promote greater use of recycled metals in building materials (State of Victoria, 2014). The Victorian government has issued separate guidelines for departments and agencies in the planning, leasing, fit-out and management of office accommodation (State of Victoria, 2007), and these guidelines include Design Principles covering materials which provide that:

The selection of building and fit-out materials must minimise the impact on the environment. Materials should be selected with minimal embodied energy to increase the building’s energy and water efficiency and maintain a healthy internal environment. Reused or recycled materials and/or those able to be reused or recycled are encouraged. Minimisation of total material consumption is encouraged (p.15).

There are also voluntary initiatives to encourage the use of more sustainably produced materials, such as certification schemes. The most notable scheme is the Green Star rating scheme which was introduced by the Green Building Council of Australia (GBCA). Credits are awarded based upon a range of performance criteria from energy and water consumption to building materials. Several GBCA rating tools encourage the use of steel produced locally from recycled scrap, including the ‘Design and As Built’ standard, which rates construction materials across nine categories including materials life-cycle impacts (GBCA, 2014a) and responsible building materials (GBCA, 2014b). Under the materials category the GBCA issued a steel sourcing standard in 2003 that encouraged the use of recycled steel in structural applications. After consultation with a Steel Expert Reference Panel in 2009, the GBCA removed the focus on high percentages of recycled steel content in new steel products, and instead encouraged dematerialised efficiencies in the production of steel as a construction material. The revised standard also recognises innovative and environmentally responsible steel production and fabrication methods (GBCA, 2010). However, despite these options several of the interview participants believe that promoting the use of recycled metals is not prioritized in the Green Star rating. Instead, energy efficiency is the main focus; for developers, increased energy efficiency lowers operational costs and is an important selling point to prospective tenants, whilst the use of metals in the building, whether recycled or not, is a one-off capital cost.

Beyond these measures, however, there appears to be little differentiation made between ore and recycled products based on price alone (Hyder Consulting 2011), and cost-based incentives currently dominate considerations. Therefore, there is competition not only between new metals and recycled metals, but also between domestically recycled metals and overseas recycled metals. This is driven primarily by the commodity prices set in international markets. The ready availability of cheaper products from overseas markets in particular can be detrimental for the competitive viability of domestic products, and the recent Free Trade Agreements struck with several major economies, including China, will only exacerbate this. Currently, the ‘dumping’ of very cheap billets produced in China at below market value is diverting demand
from domestically recycled steel. Blast furnaces producing these billets require a long time to warm up and subsequently keeping them operational is more cost-effective than shutting them down. This has meant that Chinese billets continue to be produced without corresponding demand for them, enabling them to dominate the market.

On a regulatory front, the anti-dumping regime established under the *Customs Act* 1901(Cth) and *the Customs Tariff (Anti-Dumping) Act* 1975 (Cth) may be used to seek appeals and initiate compensatory action (Australian Government 2013). However, according to one interviewee representing a company who is pursuing this, the process can be lengthy and protracted. A perusal of referrals to the Anti-Dumping Commission reveals numerous allegations by Australian businesses of the dumping of cheap metals in Australia by overseas suppliers (Australian Anti-Dumping Commission, 2015).

Overall, the demand for recycled metals in Australia is primarily market-driven, with domestically recycled metals competing against both virgin ore products and commodities imported from overseas. However, demand for all of these products is unlikely to increase without a corresponding increase in manufacturing and construction in Australia, or government regulation which sets minimum proportions for recycled metals in new products.

**REUSE, PREFABRICATION AND DESIGN FOR DISASSEMBLY**

Other types of material use and manufacturing in construction may come to affect how metals are used in buildings in the future. Such impacts may include the lifespans of metals in buildings, how metals are incorporated into buildings and what route metals take once a building reaches end-of-life.

Reuse of metal components may occur on two levels. Firstly, industrial demolition may try to sell machinery for reuse in overseas markets, particularly developing countries. However, taking into account labour dismantling and shipping costs, and that the cost of buying new machinery or facilities is quite cheap, this option is currently not commonplace. Sometimes heavy beams are retrieved and sold back on the market, but companies are sceptical about reuse because standards do not exist specifically for reused materials, and structural engineers, tasked with approving construction materials, are wary of using reused products because they cannot ascertain whether they have been structurally compromised during their use. Nevertheless, any material reuse will extend the time before they become available for recycling.

More common is the reuse of existing structural frameworks in new buildings. Construction is increasingly taking place less on undeveloped, ‘greenfield’ spaces and more so on ‘brownfield’ sites, where some development has already taken place. This means that if there is an already existing building, decisions need to be made about whether it can be partially reused and incorporated through planning into the new building, or whether it should be completely removed and recycled (Crowther 2000). Overall steel structures are relatively easy to reuse, with metal façades less amenable. The partial reuse of already existing buildings for new construction is increasingly becoming an important consideration, not only to reduce costs related to sourcing, labour and time, but also on environmental grounds invoking the reduction of waste from the construction industry as a whole.

In Australia, prefabrication, or off-site construction, has emerged as an important trend in building construction in the last decade or so. Prefabricated components are building units that are manufactured in warehouses elsewhere and then transported to and assembled on-site (Herbert 1978). They can range from individual components such as steel beams to entire modules or rooms, and the prefabrication industry is characterized by a diversity of businesses and manufacturers along with spectrum, although Australian companies are primarily small to medium enterprises. Prefabrication has become increasingly popular because they increase efficiencies in time, labour and space requirements (Crowther 2005), and in some cases are more cost-effective than traditional construction approaches. Technically, prefabrication is also becoming progressively more sophisticated, and whilst it is currently prevalent in residential developments its market share is expected to expand to include other building types as well.
However, the nascent Australia prefabrication industry must overcome barriers which undermine its widespread adoption and long-term viability. Much like reused materials, prefabricated components may be unfamiliar and difficult to certify using current standards, and so there may be an aversion to integrate these components in projects which are also partially built through more traditional means and with traditionally sourced products. Prefabrication also presents challenges to existing relationships and business approaches within the construction industry, which may lead to resistance and tension.

On a global scale, overseas prefabrication companies are also generally larger and more well-established, and careful consideration will need to be made as to how Australian companies can distinguish themselves effectively in this emerging market. In August 2015, the Victorian government released a Discussion Paper entitled “Victoria’s Future Industries – Construction Technologies” to gain insights from relevant stakeholders about how Victoria’s off-site construction industry can position itself in the global market whilst also addressing barriers such as transport and labour costs and lower economies of scale.

Ultimately, however, without consideration of the end-of-life stage of buildings, prefabrication may not embody a significant improvement in sustainable materials use compared to traditional construction approaches. Design for Disassembly (DfD) is a paradigm which considers how to design and construct buildings with a view towards their potential dismantling and partial adaptable reuse in the future (Crowther 2005). For example, it would allow for ‘localised disassembly’, in which required fit-outs and upgrades could be undertaken with minimal interruption to the rest of the building. One interviewee noted that the idea has been in broader circulation for decades in architecture, but it has only started to be applied in wider usage in the last three to five years amongst clients and government departments, for example, in hospitals. Its emergence is driven in part by increased labour costs and increasing acceptance of the benefits of flexibly adaptable buildings.

Currently, prefabrication is appealing primarily because it enables buildings to be constructed more quickly, and as the industry matures prefabricated construction may be able to perform this more cost effectively as well. However, because prefabricated buildings have only recently begun to be built, the extent to which these buildings are amenable to disassembly, or even the extent to which increasingly complex configurations could be separated and recycled, is uncertain, and market-based factors by themselves are unlikely to provoke long-term considerations in building planning and design.

These developments reveal the sharp disconnect between the construction and demolition industries, and between reuse and recycling. Both industries are subject to similar pressures related to labour and time, but these pressures manifest in conflicting ways. For the construction industry, reuse and prefabrication are appealing options because they require less time on-site, but for the demolition industry time constraints deter protracted efforts into the careful dismantling of a building’s constituent components. Consequently, even if a building was designed to be disassembled with relative ease, whether that happens once the building reaches end-of-life is treated as a separate matter. Any developments in reuse and design for disassembly may prolong the in-use lifespans of metals in buildings, potentially reducing stocks for metal recycling over the long-term.
3.4 CONCLUSION - PROPOSITIONS FOR SCRAP METAL FUTURES

Having surveyed the scrap metal recycling industry and identified the main economic and regulatory factors that affect actors at each stage, ‘propositions’ can now be suggested to galvanize more sustainable pathways for scrap metal, particular with respect to Australian buildings. In discussing these propositions feasibility (economic, political, environmental, social etc.) will not be the main consideration – instead, the discussion is intended to identify the range of possible interventions, irrespective of likelihood. Given the long lifespans of buildings, these propositions were developed for a 20-year timeframe. These propositions will be used to inform scenarios developed in collaboration with Yale University as part of P2.2, and are categorized based on scale.

International scale

As mentioned previously, the scrap metal recycling industry is driven primarily by market factors on a global scale. If a global carbon price and market is developed following international climate change discussions, this could broadly affect construction by favouring the use of recycled metals. However, this would depend on how high the carbon price is, along with design differences between national contexts. If a global scheme is implemented without consistency, then carbon leakage – in which production in jurisdictions with less stringent emissions regulations would be favoured – could undermine efforts towards increasing sustainable metals recycling and usage.

If prefabrication gains further traction within the construction industry, then the more established overseas prefabrication companies will likely have a competitive advantage in the market. This has important implications over the next two decades because it will influence how the domestic industry can position itself in the market.

National and sub-national scales

Given the dominant influence of global market-factors, legislative and regulatory measures to increase sustainable metals use at the national or sub-national scales would need to be initiated and implemented by governments.

Firstly, if Australia is to establish an advanced metals recycling industry then increasing recycling capacity and investing in the required infrastructure (e.g. non-ferrous), along with reinvigorating key manufacturing industries, would be required. This would be an initial step for Australia to create a more self-sustained metals recycling industry, one which would be less dependent on overseas processing and demand to remain viable.

In conjunction, initiatives would need to be taken to increase domestic supply. The federal government could enforce tighter regulations on exports to increase domestic volumes for recycling. Additionally, to address issues related to illegally traded flows of scrap metal, more effective policing of illegal exports and introducing stricter licensing for scrap recycling operations could undermine and reduce volumes of illegitimately sourced scrap metal being collected and sent overseas.

Metal products for construction and other important industries would also need to be considered, and prioritizing domestically manufactured products could be aided by applying stricter standards to prevent imports of inferior products, whilst also introducing procurement requirements stipulating minimum proportions of domestic products to be used in buildings. Increasing domestic demand could be refined further by considering ways to separately increase support and uptake of recycled, prefabricated and reused materials:

- Recycling: introduce regulations stipulating minimum proportions for use of (domestically) recycled metals in building projects.
- **Prefabrication**: government support in establishing prefabrication industry through, for example, updating standards and allocating funding
- **Reuse**: galvanize long-term thinking about material lifespans by legislating more disassembly and reuse at the end-of-life stage for buildings. This could be facilitated through the use of electronic identification (such as barcodes) so that components can be readily identified at end-of-life (Crowther 2005)

Overall, these propositions are intended to stimulate reflection and initiate discussions on the actions that could be taken to help Australia transition towards a more circular economy for metals. Developing national or sub-national scenarios in collaboration with Yale, that make use of some or all of these propositions, will be the next step in this process.
4. ELECTRONIC WASTE

4.1 COMMODITY CHAINS FOR E-WASTE

A wide range of activities and organisations facilitate the collection and processing of used electronics in Australia, from the acquisition, use and disposal practices of first owners in households and businesses, to the variety of commercial and not-for-profit organisations involved in collecting and sorting discarded goods, and transporting them to domestic and international sites of reprocessing.

These commodity chains are characterised by their diversity, complexity and the number of different actors and organisations involved. In general, they involve four main stages:

1. **End-of-use and disposal** - in order for used electronic goods to become available for re-use or recycling the first owner of the goods or materials needs to surrender property in them – either through abandonment (by disposal in collection facilities or dumping), through resale or through some other contractual arrangement where a 3rd party is paid to take unwanted materials away. At this stage the materials are geographically dispersed and often take the form of complex mixtures of product types and material types. At this stage a significant proportion of smaller sized electronic goods are disposed of in household garbage, thus ending up in landfill.

2. **Collection** and transport to a central sorting or processing site. There is a significant domestic industry in logistics for collection of electronic waste. Local councils commonly facilitate collection of used electronic goods from householders through drop off facilities associated with waste transfer stations and landfills.

3. **Sorting and disassembly** to collect like products or materials and to separate materials for resale or recycling from those that will be sent to landfill. This stage is labour intensive and not particularly profitable. While some sorting takes place within Australia, most disassembly of components takes place after transport to other countries, influenced by the availability of low cost labour.

4. **Resale, reuse or materials recycling** - this can involve multiple journeys and commonly involves export to other countries. It is strongly influenced by the location of processing technology such as smelters as well as the availability of low cost labour. However, there is a low level of resale of used products within Australia.

Figure 2 below illustrates these four stages and the main actors involved. The analysis provided in this section highlights the main influences on both the quantities of goods and materials and on the pathways they take towards either landfill, domestic reuse, export for reuse, domestic recycling or export for recycling. It can be drawn on to inform future scenarios for modelling material flows.
Organisations commonly involved in the electronic waste commodity chain can be divided into the following groups, and the specific organisations interviewed for each type are tabulated in Table 3:

- **Local government**, which commonly owns and manages waste transfer stations and landfill sites which provide important collection points, as well as a convenient partner for commercial businesses and social enterprise.

- **Social enterprises**, including not-for-profit community and charity sector organisations, all seek to make some kind of financial return or at least break even financially from their activities. This diverse range of organisations is distinct from commercial businesses in that their overarching purpose is the promotion of social wellbeing objectives rather than the generation of profits for owners or shareholders (Barraket and Collyer 2010). The organisations we interviewed roughly fall into the following three groups:
  - large church-based organisations with extensive networks of collection and retail facilities across more than one Australian state e.g. The Salvation Army, St Vincent de Paul Society, Lifeline (Brisbane), The Smith Family.
  - recycling centres connected with waste management facilities that link a primary goal of promoting employment opportunities and training with government objectives for waste diversion e.g. Outlook Environmental, Endeavour Foundation, Eaglehawk Eco Centre and Recycle Shop.
small niche recycling initiatives based on specific products or materials in an urban precinct with a mix of motives including employment training and supporting the needy as well as environmental concerns around materials recycling e.g. Green Collect, Computerbank, Bright Sparks.

- **Commercial businesses** also take many forms and our categorisation is based on whether they mainly collect or process materials, or if they are primarily involved with logistics and brokering of business-to-business relations. The organisations we interviewed roughly fall into the following five groups:
  - General waste management
  - E-waste collection
  - E-waste processing
  - Logistics services
  - Consulting services

- **Key industry associations** represent the concerns of different types of organisations and play an important role in lobbying government on policy matters affecting their members and these interviews were valuable for gaining a broader perspective on the range of issues and concerns across their membership.

- **Relevant state government agencies** include State and Territory Environmental Protection Authorities (EPAs) in their role as pollution and waste control ‘watchdogs’ and other government agencies involved in promoting environmental protection and sustainability. More recently agencies promoting economic development and business innovation have become more active in the waste management space.

### TABLE 3. Organisations interviewed in relation to e-waste collection and reprocessing arranged by category

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<tr>
<th>CATEGORY</th>
<th>NOTES</th>
<th>ORGANISATIONS</th>
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<td>Local Government</td>
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<td>City of Monash</td>
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<td>Social Enterprises</td>
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<td>Salvation Army</td>
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<td>St Vincent de Paul Society</td>
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<td>The Smith Family</td>
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<td>Outlook Environmental</td>
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<td>Eaglehawk Ecocentre and Recycling shop</td>
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<td>Computerbank</td>
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<td>Bright Sparks</td>
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<td>Commercial business –</td>
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<td>Hanson Landfill</td>
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<td>general waste management</td>
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The generation of e-waste in Australia is driven by rapid technological change and business models of Original Equipment Manufacturers that encourage short product lifespans and high turnover rates. While the rate of turnover differs for different product types and different sets of users, it is still high by world standards. These factors are the main drivers for increasing stocks of used electronics in Australia that are potentially available for collection.

This section will focus on factors which affect the four stages in the commodity chain for used electronic goods referred to above. The factors for each stage vary significantly according to the origins and motivations of the organisations involved. Understanding the factors which affect activities within each stage will facilitate the identification of interventions that may modify the commodity chain and promote new routes for the circularity of metals within Australia.
4.3.1 END-OF-USE AND DISPOSAL

Used electronics accumulating in households represent both a significant challenge and opportunity for both re-use and materials recycling. The national household survey of electronic devices conducted for the Wealth from Waste project in 2015 indicates that the average Australian household has 2.36 smart phones, 1.1 tablets, 1.82 laptops and 2 flat screen TVs, among other electronic devices. For electronic goods to become available for reuse or recycling, their first owners must surrender their property rights by donating them (Lane 2011, Lane 2014). A large portion of these devices stored in households are no longer being used (approximately 25% overall), yet they are still highly functional and thus of potential value for donation or resale in Australia or overseas.

The reputation of community sector organisations for altruistic activities that support the disadvantaged facilitates willingness to donate and removes some of the inhibitions about privacy concerns and surrendering property in goods and materials that could retain some form of market value. Some of the representatives we interviewed emphasised the importance of ‘brand reputation’ to their collecting operations. The representative from The Smith Family suggested that their knowledge of the full supply chain for products sold in their stores offers a significant market niche with potential to be formalised in the future through a formal certification or accreditation scheme.

Larger businesses are more likely to contract out their end of life product management to commercial e-waste recyclers on a fee for service basis. In the commercial sector, the ownership of large stocks of computers and other electronic equipment is more likely to rest with the business owner, and due to various accounting and taxation advantages, may quite often involve leasing or hire-purchase instead of outright ownership. This means decisions about disposal ‘end-of-life’ products may be integrated into a far more comprehensive business sustainability plan, including the possibility of supplier take-back schemes.

4.3.2 COLLECTION

Within the community sector, a range of models exist for collection including charity bins and drop-off centres, acceptance of donations at retail outlets, at-call collections and contracts for services to local government or business. Community or charity sector social enterprises are more likely to be engaged in activities facilitating repair and reuse of equipment within Australia where profit margins are low, and commercial enterprises in the more profitable business of exporting used electronics for refurbishing and resale in other countries. Community sector organisations operate the most extensive network of collection facilities for used goods and materials across Australia and cover rural and regional centres as well as larger cities. The larger church affiliated charities such as The Salvation Army and St Vincent de Paul Society are most significant in this respect, particularly for used durable goods and clothing. Most of what they collect comes in the form of donations of goods and materials from households and small businesses, motivated by both the convenient proximity of collection facilities and services as well as altruistic motives for helping the needy. In this respect they dominate a critical stage in the commodity chain for reuse and recycling.

The most significant challenge associated with the collection stage is that of illegal dumping, particularly outside retail stores after hours and beside charity bins located on public land, which represents a significant cost to community organisations especially if they are required to pay landfill fees for disposal of unwanted materials. Some organisations were engaging with police and local councils to prosecute those guilty, with the assistance of evidence recorded on security cameras. The issue of illegal dumping has been taken up by NACRO in lobbying state governments to acknowledge the likelihood of increased dumping as a side effect of the introduction or an increase in the landfill levy in various states (NACRO 2013). It features as a key concern in submissions by community organisations to the Victorian Government’s 2015 discussion paper, “Managing e-waste in Victoria: Starting the Conversation”.
A different collection model exists for charity organisations linked to waste processing facilities. In this case, donated goods and materials are brought to the facilities by donors, including builders and home renovators, who may be required to pay a gate fee for their disposal. These recycling centres may operate on land owned or donated by local governments who also operate the associated waste transfer or landfill facility. In metropolitan Melbourne, Outlook Environmental provides an example of a disability employment agency that has developed its operations in conjunction with local and state government policy and set targets for waste diversion from landfill. Their labour intensive operations model allows them to undertake a high level of disassembly of products into component materials, including different metal types, plastics etc., which are then sold to commercial recyclers. They are now engaging with disassembly of waste electronics, especially cathode ray tubes from TVs and computer monitors, and have contractual arrangements with a commercial e-waste recycler, MRI e-cycle solutions. Metals are sold to OneSteel, SRS and Norstar based on the best price. While money is made from commodity sales, more financially significant is the gate fee they are paid from the NTCRS for receiving and processing televisons, as the fee allows them to employ the staff required to undertake this work. Other funding was awarded by the Metropolitan Waste Management Group for infrastructure to expand the capacity of their waste transfer centres in Melbourne to increase resource recovery. As a disability employment agency, Outlook Environmental has previously obtained government funding assistance for employment training activities. While changes linked to the Disability Employment Insurance Scheme have effectively removed this subsidy, the environmental side of the business is sufficiently profitable to subsidise employment training activities if necessary.

A slightly different model again is found in the Eaglehawk Eco Centre and Recycle Shop in Bendigo in central Victoria, which was established by the not-for profit organisation, Future Employment Opportunities (FEO) and is motivated by the need for job creation and employment training for long-term unemployed in a region with very high levels of unemployment. In collaboration with the Bendigo City Council, which provided land for its operations, FEO established a facility adjacent to the Bendigo landfill aimed at diverting recyclable and reusable materials from landfill. The Centre interacts with local businesses and the regional community to receive goods and materials that are then sorted, repaired, disassembled and sold as either used goods or bulk materials. Workers develop innovations for disassembly equipment (they designed and constructed a machine for degassing refrigerators) and for adapting used goods for sale in the retail store located on the site. A computer repair shop was established that sells second-hand computer equipment. Approximately 60% of revenue comes from sales of second-hand goods and 40% from sale of materials for recycling. Any surplus is invested back into the organisation and used for new infrastructure or equipment. The Recycle Shop has strong support from the regional community who visit to both drop off unwanted goods and materials and shop for second-hand goods. The social enterprise model has now been extended to similar initiatives in other regional towns in Victoria that have developed recycle centres alongside their landfills. It also forms part of an interstate network of community recycling organisations, the Community Recycling Network Australia (CRN Australia 2015), that in turn is a member organisation of NACRO which lobbies governments on their behalf.

In addition to these larger organisations, a diverse range of small scale organisations also play a role in the collection of more specific types of goods and materials for repair or recycling on a commercial basis in urban precincts (Figure 4). For example, in North Melbourne Computerbank was established in 1998 for the purpose of collecting old computers for repair and resale at low cost, and recycling non-reusable components through disassembly and sale of components to commercial recyclers. Green Collect formed in 2002 with start-up funding from a BP corporate social responsibility program. It is focused on collection and recycling of office materials from the Melbourne CBD as a means of creating employment and training opportunities for people from disadvantaged backgrounds through collecting discarded items for reuse, remaking and recycling. Most small niche recycling organisations have some interaction with government funding schemes as providers of employment training programs, or engage with Work for the Dole.
schemes. However, as these schemes fluctuate with governmental changes, their survival depends on sales of the goods and materials they collect and process.

In 2012 approximately 300,000 tonnes of donations were received by social enterprises and, of these, 38% were reused, 12% recycled locally and 10% exported for reuse or recycling (NACRO 2013). A 2012 study on community recycling enterprises across Australia highlighted the significance of employment creation as their dominant purpose and estimated that at least 1,500 people were employed in these organisations, a considerable proportion of whom face significant barriers to employment in the open labour market (Australian Centre for Philanthropy and Nonprofit Studies 2012).

In the business sector a variety of factors have enabled new business niches to emerge in relation to increasing emphasis on e-waste recycling computing and communication devices. These include preferences for leasing of computer and communication equipment (due to accounting and taxation benefits), supplier take-back policies (e.g. Dell, HP), larger scale, continuity of supply and generally a higher residual value of devices after their first ‘life’ in use. These include niches around contracts with large corporations for a range of services connected with e-waste disposal and a range of more specific niches for brokering business-to-business relationships around e-waste collection and reprocessing (e.g. InfoActiv, Qubator). Other organisations, such as Australia Post and Seaway, simply provide logistics services for suppliers' take back schemes and advice on regulatory requirements associated with transport or export.

4.3.3 SORTING AND DISASSEMBLY

Many social enterprises have a labour intensive operations model that allows them to undertake a high level of disassembly of products into component materials, including different metal types, plastics etc., which are then sold to commercial recyclers. For example, Outlook Environmental is now engaging with disassembly of waste electronics, especially cathode ray tubes from TVs and computer monitors, and has formed contractual arrangements with a commercial e-waste recycler, MRI e-cycle solutions.

Commercial e-waste businesses experience different barriers and incentives depending on whether they are transnational companies or have their operations confined to Australia. For example, TES-AMM is a transnational business based in Singapore with reprocessing facilities in Australia (Sydney, Melbourne and Brisbane), Singapore and China. Most of the certified recycling of electronics collected from Australia is undertaken at its precious metal smelter in Singapore, allowing it to capitalise on the most valuable materials in its e-waste supply chain. Its compliance with international certifications and regulations appeals to large corporations who directly contract it for their e-waste disposal needs. Some large technology brands have their own product stewardship take back schemes and contract TES-AMM to manage them. The level of disassembly conducted at its Sydney facility far exceeds that which would be profitable based on revenue from material sales. However, it is considered important for market positioning and is cross-subsidised by the highly profitable arms of the business in Singapore and China.

MRI E-Cycle is an Australian business with e-waste reprocessing facilities in five Australian cities, avoiding the regulatory requirements involved in transporting hazardous waste across state borders. Compared with TES-AMM, the materials processed originate from a much wider range of sources, including local government waste transfer stations, charity organisations as well as small to medium enterprises. The most profitable activities it engages in are international sales of second-hand products or components but most clients prefer the materials recycling option.

TES-AMM has developed a market niche based on its capacity to meet the requirements of the Basel Convention and various international certification schemes for electronics processing. It operates relatively independently of the Australian policy environment, although must comply with State and National regulations. MRI E-Cycle engages in a wider range of activities, as it collects material from a wider range of sources, including from local government collection services and donations to charity organisations. As all
its facilities and activities are located in Australia, it has much greater exposure to Australian government policy.

### 4.3.4 RESALE, RE-USE OR MATERIALS RECYCLING

Activities that facilitate the redistribution and re-use of goods and materials within the community are generally assisted by the reputation for charitable works in the community, as well as those factors affecting any retail outlet including the location and layout of stores and perceived value for money. However, there are a range of regulatory pitfalls as the goods in question straddle the boundary between commodities and waste. The terms of exemption from second-hand traders’ legislation and licensing fees differs in every State, whilst occupational health and safety requirements and hazardous waste management rules also create significant compliance burdens. Goods and Services Tax liability could also be triggered, but in general, the sale of donated second-hand goods by a registered charity is exempt from GST, provided there is no change in the original character of the goods (ATO, 2011).

While charity sector organisations are central to the circulation of used goods and commodities, and do engage with recycling of some commodities, such as reprocessing unusable textiles into saleable rags, most materials recycling is brokered by commercial businesses. There are facilities for recycling plastic, glass and paper within Australia, but most metal recycling is undertaken offshore, with commercial businesses in Australia managing logistics for collection and sales to offshore buyers.

For e-waste reprocessors like MRI, payment for services in a service provision business model may be more significant as a source of revenue than profits from the sale of component materials, although some high value components such as computer CPUs do generate significant revenue, and resale for reuse may also be profitable. Other businesses focus specifically on resale of second hand devices especially to overseas markets (e.g. Mazuma, Cash-A-Phone). It is illegal to export non-working electronics overseas outside of legally recognised certified schemes such as Mobile Muster. The Wealth from Waste household survey conducted in 2015 found that most Australian households store electronic devices such as mobile phones and tablets that they no longer use but that are still functional, and this suggests that there is potential for a larger trade in second hand products.

### 4.3.5 DISCUSSION

The e-waste recovery sector has two dominant but sometimes contradictory drivers – 1) policy and regulation which is primarily grounded in concern to manage a hazardous resource, and 2) profit generation which may be partly driven by policy and regulatory requirements and partly driven by end markets for the resources including component materials, especially precious metals, but also second hand goods. These end markets are strongly influenced by fluctuations in the price of metals shown on the London Metals Exchange. The highest costs involved in the commodity chain are the logistics of collecting a dispersed resource. While larger corporations are likely to have contractual arrangements in place of e-waste disposal, this is less likely to be the case for households and SMEs so government policy and regulation is required to provide incentives for collection.

Only some of the activities involved in collection, reuse and recycling of specific products and materials are profitable on a commercial scale and the largest costs involved are primarily in the collection, sorting and, where undertaken, disassembly and repair work. NACRO is concerned that new product stewardship initiatives assume that the charity sector will undertake unprofitable activities while the commercial sector performs profitable activities. In government policy and legislation, there is an assumption that innovation in emerging recycling industries will be driven by the corporate sector based on profit motives. However, we found much evidence of innovation within charity sector organisations in the collection, sorting and
disassembly/repair stages of the commodity chain. For example, workers at the Eaglehawk Eco Centre and Recycle Shop in Bendigo had designed and constructed a machine for degassing refrigerators and separating their different metal components. This was motivated by the desire to generate new employment opportunities rather than profits per se. The St Vincent de Paul Society has designed a trolley with a spring-loaded platform that reduced the risk of volunteer workers experiencing back strain. This was motivated by their desire to maintain a comfortable work environment that continued to attract volunteers. Much of the computer repair work for resale was unlikely to generate profits on a commercial scale, but nevertheless provided employment and training opportunities valued by those undertaking the work.

The role of the charity sector in these commodity chains, while significant, can be somewhat fraught. For instance, the exemption of not-for-profit sector from normal licensing and taxation obligations means record keeping and disclosure is less stringent, and thus there is a serious gap in the economy-wide data on stocks and flows of second-hand goods in this sector.

**EFFECTS OF THE NTCRS ON ORGANISATIONAL LANDSCAPE**

In 2011 the National Television and Computer Recycling Scheme (NTCRS) was introduced, a government and industry co-regulated national product stewardship scheme that subsidised collection of these items. While the rationale for the scheme was grounded in the logic of hazard, its design and implementation engaged a logic of resource that aimed to foster a local recycling industry. The scheme resulted in a significant increase in quantities of used computers and television collected and disassembled (Commonwealth of Australia 2014). It also precipitated a shift in the primary collecting organisations away from charity organisations and resale or reuse towards commercial businesses and materials recycling (Fig. 6).

While the transnational business, TES-AMM, was barely affected by the scheme, Australian businesses such as MRI E-Cycle were strongly affected and most of their income now comes from gate fees paid to process computers and TVs under the NTCRS rather than sales of used commodities. New requirements that all leaded glass from CRT monitors be processed at Australia’s only lead smelter at Port Pirie in South Australia impose additional costs more easily born by larger organisations with higher throughput. MRI E-cycle formed a partnership with the social enterprise, Outlook Environmental, specifically for the disassembly of computers and TVs as there is no provision for resale under the scheme. This benefits Outlook Environmental which receives a gate fee for taking equipment and is able to employ and train more people to undertake the work. Outlook Environmental is embedded in a wider range of government policy areas including employment and social policy as well as waste management and resource recovery. Its purpose in undertaking electronics reprocessing is to generate employment. While it engages in a range of market activities, it would not exist without non-market activities and market activities mediated by government policy. It benefits from government policy relating to both employment training objectives and waste diversion from landfill targets. Similar patterns are evident in the activities of the Endeavour Foundation and Resource Recovery Australia, both of which have expanded their activities to take up emerging opportunities in the management of local government waste transfer stations. These activities also involve new partnership arrangements with commercial e-waste recyclers.

Because the NTCRS precipitated new opportunities for profit generation in reprocessing activities such as the management of local government materials recovery centres, there is now competition between these social enterprises and commercial businesses for council contracts. While some local governments include social procurement requirements in their contractual arrangements, all must comply with the provisions of Australia’s National Competition Policy to award contracts based on value for money. Further discussion of the impacts of the NTCRS is provided in Section 4.4.2 below.

Figures 3 and 4 show the impacts of the introduction of the NTCRS scheme on commodity chains for used electronics in Australia.
FIGURE 3. Commodity chains for e-waste collection and reprocessing prior to the introduction of the NTCRS

FIGURE 4. Commodity chains for e-waste collection and reprocessing following the introduction of the NTCRS
4.4 REGULATION AFFECTING E-WASTE COLLECTION IN AUSTRALIA

This section will provide an overview of the legal or regulatory factors bearing upon the commodity chain for e-waste at each of the various stages, with a view to identifying any particular barriers or enablers of innovation that may deserve further consideration.

4.4.1 END-OF-USE AND DISPOSAL

The owners of electronic products are generally not bound by any statutory obligations to dispose of those products in a manner that promotes re-use or recycling. The constitutional division of legislative powers under the Australian Constitution has traditionally placed responsibility for making laws on pollution and waste disposal with State or Territory Governments, whose EPAs play the role of environmental watchdog. If unwanted electronic products are simply discarded in public, minor criminal offences could apply for littering or pollution under State and Territory environment protection laws, but the penalties are small.

Unwanted electronic products may of ten be discarded in general household rubbish placed in kerbside collection bins, which is a common pathway for the unwanted outcome of e-waste going into landfill. Landfills and waste recycling facilities are usually managed by local government and private enterprise and these facilities must comply with operating licences administered by the EPAs. At present most Australian States and Territories do not have bans on e-waste going into landfill so householders in those jurisdictions are not breaching any specific laws. Landfills bans now apply in South Australia and the ACT, and also currently under consideration in Victoria (Hyder 2010, State of Victoria 2015).

In Victoria, the Environment Protection Act was amended in 2002 to foster environmentally sustainable uses of resources and best practice in waste management (under Part IX—Resource Efficiency). This reform established a new statutory corporation, Sustainability Victoria, to oversee industrial waste management plans, a Metropolitan Waste Management Group, to facilitate local government waste management and resource recovery services, and Regional Waste Management Groups, to plan for municipal waste within a certain declared regions. Landfill operators must pay to the EPA a landfill levy for each tonne of waste deposited at their premises pursuant to the Environment Protection (Industrial Waste Resource) Regulations, 2009. The current rates vary from $22 to $58.50 per tonne depending upon the source (municipal vs. industrial) and nature of the waste. Waste is categorized as Category A (most hazardous), Category B or Category C (least hazardous). Category A waste cannot be disposed of in landfills at all unless processed to a less hazardous state. There are some 35 landfill sites across Victoria and only one (Lyndhurst) is licensed to receive Category B waste (EPA, 2013). In effect, the landfill levy is paid by households and businesses that deposit waste at those sites, providing a price signal to discourage the quantity of waste sent to landfills. The revenue raised by the levy contributes a major portion of the funding of EPA operations in Victoria. Some serious shortcomings in the management of landfills by the EPA and local councils in Victoria were highlighted in an Ombudsman’s inquiry into a serious methane leak at a landfill on the outskirts of Melbourne (Brouwer, 2009). A separate report by the Victorian Auditor General’s Office into EPA management of hazardous waste also found many deficiencies in record keeping and procedures within the EPA (Frost, 2010). The EPA responded to these criticisms by instituting its own Compliance and Enforcement Review (Kran, 2011) and recently announced that it had implemented 117 of the 119 recommendations from that review (Batagol, 2013). In 2013, the Victorian Government issued a new vision for waste and resource recovery called Getting Full Value: the Victorian Waste and Resource Recovery Policy (State of Victoria, 2013), which seeks to engage industry all levels of government to adopt a shared approach to the management of products at end-of-life, moving (like the national policy) away from government-driven waste collection to industry-based product stewardship schemes (Barnaby and Polhill, 2013).
Sustainability Victoria has established a range of programs delivered in partnership with local governments that are directed to recovery and recycling of certain problematic household waste products including “Detox Your Home” (for household chemicals) “Battery Back” (for used household batteries), “Byteback” (computers and peripherals) and “Paintback” (paint).

In the commercial sector, Victoria has pioneered several regulatory mechanisms to promote resource efficiency in a broader sense. Under the Industry Greenhouse Program introduced in 2002, firms using over 500GJ of energy and those emitting over 100 tonnes of CO$_2$eq greenhouse emissions were required to carry out an audit to identify investments in energy efficiency that would have a payback period of three years or less. This program proved to be extremely successful with many firms finding energy efficiency investments that would pay for themselves in less than one year, with the added bonus of significant greenhouse emission reductions (EPA, 2007). In 2006, the Industry Greenhouse Program was extended to include measures to promote management of water consumption and waste under the Resource Efficiency Plan (EREP) scheme (EPA 2008). The extended scheme required all commercial and industrial sites consuming over 100 TJ of energy and/or 120 mL of water per annum at 1 January 2008, to identify and implement actions reducing energy, water and waste that would a payback period of three years or less. By 2013, over 250 companies had participated in the EREP program and collectively saved over 100,000 tonnes of solid waste. Despite these impressive results, the Victorian government terminated the EREP program in 2014 as part of its “Red Tape Reduction Program” (Regulatory Impact Solutions, 2013).

Key industry players such as the manufacturers of electronic products as well as the main distributors and retailers can have a profound impact upon re-use and recycling outcomes through a range of voluntary corporate environmental responsibility strategies. Voluntary corporate strategies are a vital counterpart to neo-liberal regulatory policies embraced by all Australian governments since the 1990s, whereby direct command and control style regulation has been wound back on the premise that industry self-regulation produces more efficient outcomes (Gumley 2014). Many manufacturers now implement corporate product stewardship and/or extended producer responsibility policies by providing mechanisms for ‘take back’ of end of life products – e.g. pre-paid mail bags for returning to a recycling facility (eg. HP, Dell). Some have made arrangements with major retail outlets for used products to be returned at the place of purchase (eg. Officeworks). For leased equipment the obligation to return products at the end of the lease is a contractual obligation enforced by common law. There is great scope for all electronic purchase contracts to include carefully structured product return obligations, with some appropriate incentive provided to encourage performance – e.g. customers returning a used product could be offered a sum of cash, a discount on the purchase of a replacement product, or points towards a consumer loyalty program. There is already a vast array of implied terms under consumer protection laws at both Commonwealth and State levels which modifies consumer contracts for purchase of goods in order to promote product safety and fairness to consumers under the Competition and Consumer Act 2010 (Cth). Similar statutory provisions to promote take back of electronic products, and improvements in design for recycling are clearly justified given the mounting community costs imposed by e-waste.

4.4.2 COLLECTION

The difficulties in managing the dispersed situation of end of life electronic products in Australia has led the Commonwealth Government to take legislative action to encourage manufacturers and importers to take greater responsibility for collection and recycling. In 2009, the Australian Commonwealth Government released a National Waste Policy which recognized that continued growth in waste streams and the more complex nature of the current waste load (such as increasing e-waste) demonstrated the need for “holistic approaches which address market, regulatory and governance failures, duplications and inconsistencies” whereby “waste streams are managed as a resource” (Commonwealth of Australia 2009). This policy includes a guiding principle that “participants in the product supply and consumption chain, rather than the
general community, bear responsibility for the costs of resource recovery and waste management” with an objective that by 2020 “Governments, industry and the community have embraced product stewardship and extended producer responsibility approaches … leading to improvements in the design, longevity and disassembly of products, a reduction in hazardous content, less waste, and more thoughtful consumer choices.” This policy represents a significant re-commitment to several fundamental principles of sustainable development, including the internalization of environmental costs and polluter pays principles (UNCED 1992). It also envisages the adoption of new regulatory measures to promote product stewardship and a more circular economy. The Ellen MacArthur Foundation (EMF) has described the “circular economy” as one:

“That is restorative or regenerative by intention and design. It replaces the “end-of-life” concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.” (Ellen MacArthur Foundation 2012).

The National Waste Policy adopted self-regulatory, co-regulatory and informational arrangements as its priority strategies, rather than levies and charges. One of the first co-regulatory schemes launched under this policy was the Australian Packaging Covenant, which encourages major industry players to design more sustainable packaging, increase recycling rates and reduce packaging litter Commonwealth of Australia, 2010). In 2011, the Product Stewardship Act 2011 (Cth) was introduced to provide a statutory framework for a wider range of measures to more effectively manage the environmental, health and safety impacts of products, particularly impacts associated with disposal of products. One of the first schemes introduced under that Act is the National Television and Computer Recycling Scheme (NTCRS) which is a government and industry co-regulated product stewardship scheme to promote more effective collection and recycling of relevant electronic products. Similar schemes have been operating for longer periods overseas, most notably, the EU Directive on Waste Electrical and Electronic Equipment (European Parliament, 2012) whereby Member States must establish systems for users and distributors to return household electrical and electronic equipment (EEE) waste to collection facilities free of charge, and requires producers to finance the collection and processing of EEE waste at these facilities. For non-household EEE, producers are obliged to provide for the collection of such waste by joining a collection scheme. However, the specific schemes introduced pursuant to this Directive can vary significantly from country to country.

The NTCRS operates by setting a range of general obligations for “liable parties”. The first co-regulatory scheme established covers importers and manufacturers of televisions, computers, printers and peripherals, with liable parties specified by regulation as importers or manufacturers of over 5000 units (or 15,000 for peripherals). The general obligation is for liable parties to join an “approved co-regulatory arrangement”, which specifies certain outcomes within a range of general objectives (set out in Section 21). The NTCRS regulation further elaborates the required outcomes as:

1. reasonable access to collection services in metropolitan, inner regional, outer regional and remote areas must be provided (free of charge to households);
2. certain recycling targets for each product in the class must be met in each year; and
3. a material recovery target must be met in each year (from 1 July 2014) (Regulations 3.01–3.03).

Based on discussions with some of the scheme participants and a wide range of other stakeholders during the first year of our project, it is clear that the NTCRS has been successful in a broad sense. However, we believe there are several areas for improvement in the operational settings of the scheme which could improve its overall effectiveness. In the first two years of the NTCRS it has ‘over-achieved’ by delivering more units to collection centres than was envisaged by the scheme designers (particularly for televisions). This has placed financial stress upon the five collection contractors engaged under the scheme (“the
contractors’), as they have been contracted to collect and recycle an agreed volume of units and have no responsibility for handling the significant number of additional units that have been dropped at collection centres under the scheme. This problem may have arisen because the scheme targets were not based upon real data on the total flow of waste computers and televisions, but instead used a proxy ‘waste arising’ formula based on the average weight of imports over the past three years. In order to address these problems from an operational perspective, there are at least four areas for improvement as detailed below.

Firstly, collection targets should be set by reference to the real stock of waste not a rigid formula. The current ‘waste arising’ formula does not accurately reflect the actual quantity of discarded products made available for recycling in the relevant year (which is formed by many factors that vary from year to year including product lifespan, technology changes, consumer behaviour such as hoarding and reuse patterns, as well as broader economic conditions). The number of devices in use, their variety, average weight, average lifetime etc. will change over time, and should not be viewed simplistically as just a replacement of one device by another similar device. A more accurate modelling approach can be applied using empirical evidence of real waste stocks and flows, not just import statistics.

Whilst the current formula may have provided a useful estimation for scheme design purposes, the explanation of what units enter the waste stream in later years is far more complex. Indeed the 2010 Wright-Rawtec report, which prompted much of the scheme design, foreshadowed a number of important factors that would affect future recycling and reprocessing patterns, including the changing technology of televisions due to the transition away from bulky analogue CRT models to digital units, with larger but flatter LCD and plasma screens (Wright Corporate Strategies and Rawtec 2009). A variation in computer stocks was also foreshadowed due to the trend away from desktop computers to lighter and smaller units, with a general trend to less glass and plastic, along with the recent expansion of e-waste collection centres. For these reasons, at the very least it seems misleading for computers and televisions to be included together under the same targets as there are clear differences in product trends and discard patterns. We suggest that the extensive international experience on measurement of e-waste stocks, incorporating more sophisticated assessment of product lifespans, could be highly instructive. Relevant studies have been completed at research centres such as the National Institute of Environmental Studies in Japan over many years (Kim et al. 2013, Oguchi et al. 2008, Oguchi, Sakanakura and Terazono 2013, Yoshida and Terazono 2010).

Secondly, the future operation of the Scheme should be based upon an adaptive management approach rather than rigid targets. The long-term NTCRS collection target of 80% faces seems to be based upon an arbitrary division of responsibility between the liable parties (and their contractors, who all have a commercial interest in the scheme), and the rest of the community – particularly local government and not-for-profit organisations, which are motivated by public interest. Given that the Commonwealth Government has exclusive responsibility for hazardous waste exports and now, through the NTCRS and other measures, has also taken a central role in managing e-waste, it can be strongly argued that this goal should be 100% in the interests of economic efficiency and best practice in waste management. There are legitimate concerns about free riders and unauthorised export flows for product reuse overseas which highlight a clear need for more accurate modelling to enable e-waste stocks and flows to be better quantified.

The long-term collection target should aim to move this sector towards a zero waste outcome which would be far more compatible with product stewardship and environmental management system principles such as that of ‘continual improvement’, as required by the ISO14001 Environmental Management System specifications in. This may require that liable parties must be provided a more flexible level of funding to meet the full scope of the recycling task each year, and not just an arbitrary figure that may or may not be adequate, depending upon how many units are liberated from hibernation as a result of the scheme.
Adaptive management strategies are commonly applied to address uncertainty in other areas of regulation, such as fisheries catch quotas, development approvals and impact assessment processes. The essence of adaptive management is ongoing research and monitoring of outcomes against objectives, and this will necessarily involve well-resourced information gathering systems to support such monitoring, as well as flexible processes for amendment to scheme settings. The addition of these elements to the NTCRS will greatly improve the prospects for an innovative, resilient and sustainable recycling industry in Australia.

The current material recovery target of 90% seems to lack any mechanism to promote reprocessing of e-waste in Australia, which may arguably be in conflict with the terms of the Basel Convention (UNEP, 1992). It is clear that most material recovery from computers and televisions currently happens overseas, not in Australia. The e-waste “recyclers” in Australia are usually responsible for the collection and basic separation of the collected waste. The level of separation (e.g. into metals, plastic, glass and printed circuit boards) may significantly vary between companies. It appears that high levels of reported material recovery often means that less separation and recovery happens in Australia as the collected amounts are exported overseas for reuse or recovery, meaning any residual waste after material recovery is often being disposed of in unregulated circumstances overseas. There is a clear need for additional standards to regulate how unprocessed waste exported under the NTCRS is dealt with overseas. The new joint Australian and New Zealand Standard, (AS/NZS 5377:2013 Collection, storage, transport and treatment of end-of-life electrical and electronic equipment) outlines minimum requirements for the safe and environmentally sound handling of e-waste in Australia, but there seems to be no mechanism for ensuring that downstream reprocessing facilities overseas will meet the same minimum standards. Clearly, funding for collection services under the NTCRS should be directed not just to the collection of waste but also to systems for verification that material recovery has occurred by reference to quantitative information on the degree, location and type of processing and recovery.

Thirdly, the financial model for the NTCRS should be more transparent. The NTCRS envisaged that recyclers and other service providers would be contracted under co-regulatory arrangement through a competitive market. The Wright-Rawtec report predicted many risks and limitations associated with an artificially created market of this type, and some of these factors (particularly the uncertainty on stocks and flows) have contributed to the current undersupply of recycling and reprocessing services. There is considerable scope for misalignment between the objective of creating a discrete competitive market in e-waste collection services within Australia and providing a solution to the much larger problem of extensive externalities created by the multi-national electronic goods market. NTCRS liable parties need support through a more flexible budget to allow for fluctuations from year to year (eg. funding should be transferable between years rather than ‘given away’ on a year-by-year basis based on the collection target). It is now very apparent that a higher collection target was required in the earlier years to deal with shorter term factors such as the digital TV transition whilst also maintaining reserve of funding for unknown future contingencies.

Finally, the NTCRS should be supported by more comprehensive data. Regardless of the intention and limited objectives of the NTCRS, it seems that the initial publicity and involvement of commercial operators and various external factors have combined to produce a surge in the discard of e-waste which has overwhelmed the capacity of the scheme and left significant stockpiles in the hands of contractors and local government collection agencies. This result was largely due to a lack of reliable data on stocks and flows to inform forward planning by scheme participants. Government regulators, liable parties and other business participants all need a much higher quality data set on e-waste stocks and flows to support forward planning and future investment decisions. Unfortunately, several information gathering systems that should meet this need are unreliable or have been recently weakened. The Commonwealth’s National Pollutant Inventory provides a useful framework for information of this type but it is currently too limited in scope, and much of its data is self-reported by industry with little or no verification. The 2010 National
Waste Report provided a useful start for compiling an overview of waste generation and recycling generally, but is now well out of date and needs to be updated and expanded.

4.4.3 SORTING AND DISASSEMBLY

The process of sorting and disassembly of electronic waste products is primarily regulated by general State or Territory legislation covering industrial activities involving potentially hazardous materials, which falls within the responsibility of the relevant EPAs. Legislation like the Victorian Environment Protection Act 1970 typically requires that the location of any high risk activities (designated as ‘scheduled premises’) must obtain a works approval on commencement (for a new activity), and an annual licence imposing strict conditions for management of waste with particular emphasis upon discharges to air, water, land, and noise. The Dangerous Goods Act 1985 (Vic) also sets out the general duties for the manufacture, storage, transport, sale and use of dangerous goods in Victoria, and the Occupational Health and Safety Act 2004 (Vic) sets out the key principles, duties and rights in relation to occupational health and safety, including a general duty upon employers to provide and maintain a safe and healthy workplace for all employees and contractors.

4.4.4 RESALE, REUSE AND MATERIALS RECYCLING

The existence of markets for the export of waste and used goods brings international law into consideration. The most notable treaty in this field is the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (()), which commits participating nations to reduce the production of hazardous waste and to restrict its trans-boundary movements. The Basel Convention has 180 participating nations, including Australia. However the USA, one of the world’s greatest waste producers, has not implemented the Convention, due in part to potential conflicts with US laws, including the Resource Conservation and Waste Recovery Act (1994), and comprehensive EPA waste management requirements (Gaba, 2012). The Australian Government enacted the Hazardous Waste (Regulation of Exports and Imports) Act 1989 (Cth) to implement its obligations under the Basel Convention, as well as guidelines for the transfer of hazardous waste between States and Territories (NEPC, 2010). Given the rapidly growing market for trade in used electronic goods, it has been suggested that restrictions on waste movement under the Basel Convention may be in conflict with free trade rules (Kogan, 2004). However, the World Trade Organisation has stated that the principles of non-discrimination and transparency do not conflict with trade-related measures needed to protect the environment (Widawsky, 2008). The OECD also has a number of Directives relating to the movement of waste between member nations which establish a two-tier system for “green” and “amber” (hazardous) wastes which inter alia, requires the exporting country to re-admit any amber waste if it cannot be recycled as intended by the original consent procedures (OECD, 2001).

4.5 CONCLUSION - PROPOSITIONS FOR E-WASTE FUTURES

Our investigations of the e-waste collection sector show that dedicated e-waste collection and reprocessing businesses operating only in Australia are highly sensitive to various local regulatory measures, including the co-regulated product stewardship scheme for computers and TVs. They are also highly sensitive to EPA regulations on hazardous materials such as leaded glass from monitors. This underlines the importance of well-structured legislation to guide future developments in this sector. Governance arrangements for relevant regulators like State EPAs in Victoria and NSW have been restructured considerably in recent years, which has tended to result in EPAs retaining the responsibility to make sure that waste material is lawfully disposed of whilst others (from both government and private sector) increasingly take
responsibility for encouraging re-use and recycling. These regulatory overlaps and the transitional character of the e-waste sector have caused significant additional costs such as a range of new audit requirements for e-waste reprocessors.

As mentioned above with regard to scrap metal, high landfill levies drive considerable e-waste recycling efforts (particularly due to the hazardous categorisation of many components). Waste management companies also add a substantial mark-up for every tonne sent to landfill, which increases the incentive for diversion into recycling. The hazardous characterisation of e-waste also triggers the need for e-waste reprocessors to have facilities in each state to avoid regulatory requirements linked to transport of hazardous materials across state boundaries.

Market factors such as fuel prices and metal prices affect the geographic range that e-waste collection companies are willing to service. Drivers may receive performance bonuses which reinforce the economics of collection services but traffic congestion and high real estate prices are also barriers to collection and reprocessing in metropolitan areas of the larger cities.

The global market for used e-waste detracts from investment in local reprocessing facilities even where the economics is viable. The high capital investment required, lack of economies of scale and relatively small local population and corresponding supply uncertainties all create an incentive for the local collection industry to take a bird in the hand (export price) instead of two in the bush (potential gain from reprocessing) approach. The current economic model for recycling is also contributing to significant illegal exports of e-waste; many certified recyclers report being approached by agents wanting to buy e-waste for unauthorised export.

Whilst the NTCRS has been hailed a success based on tonnage collected, there are many reports that co-regulators filled quotas well ahead of expectations, with the result that large amounts of accumulated e-waste materials were consequently sent to landfill.

Having surveyed the landscape of organisations involved in collection, reprocessing and reuse, resale or recycling, and identified the main economic and regulatory factors that affect activities at each of the four stages identified, ‘propositions’ can now be suggested that could affect the future of e-waste in Australia in a five year time-frame. These propositions are presented in terms of business as usual versus various policy or management interventions and they can be used to inform scenarios developed in collaboration with Yale University as part of P2.2.

**Business-As-Usual**

- **Stocks of electronics continue to increase.** The current pattern shows new electronic products coming on to the market at a steady rate, and that uptake of new ‘high end’ products like smartphones and tablet computers is still increasing across the community.
- **Working electronic products are hoarded in households.** Hoarding continues due to privacy concerns over stored personal data and the convenience of having a second or third unit as a back-up in case of loss or damage.
- **Collections under national product stewardship schemes continue to be erratic.** Despite the provision of free collection sites in most communities by liable parties under the NTCRS, rigid collection targets and regular changes in technology and usages patterns will cause significant divergence between anticipated and actual e-waste collection and recycling under such schemes.
- **Competition between commercial and not for profit organisations in collection and reprocessing.** Whereas the NTCRS has created a fast track for recycling and export of end-of-life units for processing overseas on a commercial basis, the pre-existing second hand market for re-use of electronic products largely operated by social enterprises and the not-for-profit sector will reduce supply for commercial operators (and vice versa)
- **Product lifespans continue to decrease.** As consumers become more dependent upon electronic products manufacturers will increase the functionality of newer models to encourage more rapid renewal and updating of products.

- **Product complexity continues to increase.** Increases in functionality will be largely achieved through new technologies and new material components that make each unit progressively more complex.

- **Significant portion of used electronics exported illegally.** As ever more sophisticated new products are regularly released into the market the second hand value of ‘still pretty good’ superseded models will trend upwards, increasing demand for illegal trade, particularly to unregulated markets in developing countries.

**Policy/ management/ technology interventions**

**Regulatory measures**

- **Landfill bans.** In an effort to prevent dumping of e-waste in landfills, some States have/will introduce a prohibition against placing e-waste in landfill. Landfill levies can deter bulk disposal to landfill but households can still easily place occasional e-waste items in household garbage (which may not be sorted at transfer stations?).

- **Effective policing of illegal exports.** Additional resources provided to local law enforcement agencies, improvements in export procedures and monitoring technologies, better categorisation of e-waste and stronger regulation of container shipping industry combine to minimise illegal shipments of e-waste.

- **Fully commercialised collection system** (through accreditation systems). Sufficient funding could be raised through levies (on consumers/industry) to support a fully commercialised collection scheme that recovers almost all end-of-life e-waste for supply to accredited recycling and/or re-use outlets.

**Better collection incentives**

- **Increase in consumer buy-back schemes.** Innovative schemes are introduced to encourage buy back and recycling of end-of-life electronic products. For example A new legislative scheme modelled on the NSW Energy Savings Scheme could be introduced to require retailers and certain other parties who buy or sell electronic products, to set a product stewardship/resource recovery target and to acquire sufficient ‘resource savings certificates’ to meet that target (in place of the NTCRS).

- **Increased use of leasing arrangements.** Business and government procurement policies shift increasingly in favour of equipment leasing arrangements and this spreads to private consumers, providing a legal obligation for return of end-of-life items, and far more effective recycling pathways.

- **Second hand exchanges facilitated so products have longer in use lifespan.** Social enterprises and micro-business operators increasingly intercept end-of-life electronic goods that are in working order for sale and re-use.

**Information measures**

- **Product stewardship schemes informed by more accurate information base.** Better data collection methodologies inform material flow analysis techniques to provide more accurate data for improvement of product stewardship schemes.

- **Provision of consistent public information about responsible disposal options and collection points**
**Technological measures**

- **Technological solutions to security concerns.** Better regulation and advances in digital security software and memory erasure techniques make users of electronic products more comfortable to pass end-of-life products to accredited recyclers.

- **Design for reuse/longevity.** Legal frameworks like the EU Eco-Design directive and voluntary extended product responsibility initiatives produce longer lasting electronic products and/or less complex, more easily recyclable products.

- **New technology for local disassembly and reprocessing**
5. CONCLUSION

5.1 COLLECTION SYSTEMS REFLECT THE DIVERSE ECONOMY OF METALS RECYCLING IN AUSTRALIA

This report highlights the diversity of commodity chains for metals recycling in Australia and of the types of organisations that facilitate the movement of discarded goods and materials along pathways to reuse, resale or recycling, either within Australia or in other countries. In particular, it shows how different types of organisations are influenced by different sets of barriers and incentives, with some more exposed to the Australian policy and regulatory environment than others. Because of this diversity, measures taken to facilitate the activities of some types of organisations without acknowledging they may have different impacts on others can have perverse effects on the entire commodity chain for collection and processing of used scrap metal and electronics.

While some parts of these commodity chains are clearly motivated by the potential for capturing market value and generating profits, these motives alone cannot account for the entire commodity chain, particularly that part that involves disposal of products and materials by their former owners and their collection and transport to central locations where sorting and disassembly is undertaken. It is not until they re-emerge in the form of new commodities that more conventional market dynamics come into play. Failure to recognise and acknowledge these dimensions can lead to a misunderstanding of the dynamics of what many now refer to as the circular economy (Hobson 2015).

With respect to e-waste in particular, the review of the impact of Australia’s NTCRS showed that this particular initiative reshaped supply chains in a way that reinforced pathways to materials recycling, rather than reuse, and ensured a level of disassembly takes place in Australia prior to export. This confirms with observations of the impacts of product stewardship regulatory initiatives in other countries (e.g. Tong et al. 2015 on China). Not-for-profit social enterprises were bypassed in the collection stage but acquired new roles in disassembly of products into component materials on a cost recovery basis, work that may previously have been undertaken in other countries lacking equivalent environmental and health standards. As with the EU recycling initiatives discussed by Gregson et al. (2014) the NTCRS is based on an underlying assumption that a viable commercial industry can be generated in a high labour cost country prompted by regulatory incentives. This emphasis on market motives results in a focus on employment opportunities in commercial recycling and associated logistics. However, partnerships with social enterprises may be critical for manual disassembly and sorting within Australia and this sector may expand as a result. More broadly, these findings highlight the need for greater understanding of dynamics of labour in the circular economy around metals recycling as it is enacted through policy and governance initiatives worldwide (Gregson et al. 2014, Alexander and Reno 2012, Pickren 2014, Hobson 2015).

5.2 UNDERSTANDING OF COLLECTION SYSTEMS FACILITATES SCENARIO MODELLING

The research presented in this report highlights the complexity of factors that might contribute to future scenarios for increased collection rates for recycling or reuse, and for increasing the scope of activities within Australia. However, to develop scenarios for modelling future material flows, more detailed information is required for specific products and material types. In particular we need estimates of the quantity and geographical distribution of the potential resource, and of the lifespans of current in-use stocks. These estimates are being developed through other research projects running concurrently with the Collection Systems research presented here. They include:
1. The development of a proxy indicator for quantities of steel, copper and zinc in different types of buildings in Australia and approximations of the expected lifespans of different types of buildings in Australia. Proxy indicators can then be linked to census data on buildings in Australia with information on building type, age and location. This work builds on a prior study by van Beers and Graedel (2007) which analysed the spatial patterns of the in-use stocks of copper and zinc at four spatial scales in Australia, and is also informed by a study by Tanikawa and Hashimoto (2009) which estimated construction material stocks over time with spatio-temporal data in a Japanese city and a British city.

2. A national survey of household electronics focused on identifying socio-demographic patterns in the distribution of ten types of electronic products in Australian households, which also gathers information about current patterns in the storage or disposal of these items. This information can also be linked to Australian census data to map current patterns in the distribution of the resource and provide estimates of product lifespans and availability for recovery over time.

Central to these exercises is the compilation of data in an interactive Atlas of Recyclable Resources, for which a prototype has already been developed (Zhu 2014). The quantification of stocks and flows, along with distance to reprocessing facilities, will facilitate an economic appraisal of the potential resource, under different future scenarios, and an appraisal of the environmental impacts of specific product types through Life Cycle Assessments.

The next stage of the research will involve collaboration with researchers at the Centre for Industrial Ecology at Yale University (P2.1) to progress.
REFERENCES


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Hyder Consulting. 2010. Landfill ban investigation; Final Report (for Department of Sustainability Environment, Water, Population and Communities). Available at:


Kama, K. 2015. Circling the economy: resource-making and marketization in EU electronic waste policy, 47.1 Area 16-23.


APPENDIX A: INTERVIEW QUESTION GUIDE AND EXPLANATORY STATEMENT (METALS IN BUILDINGS)

Topic 1. What is the estimated amount of metal in buildings and urban infrastructure? We are particularly interested in steel, copper and zinc.

Topic 2. With respect to prefabricated components in particular, where are these metals (steel, copper, zinc) and other metals found?

- What factors motivate the use of prefabricated components?
- To what extent, and why, do you think this will change over time?

Topic 3. What are the expected lifespans for Australian buildings and urban infrastructure and what factors are most influential?

- What are the average lifespans of different types of buildings and urban infrastructure?
- What factors (material, economic, regulatory etc.) affect lifespans of these structures and what is the relative importance of these factors in affecting lifespans?
- How and why have these factors changed over time?

Topic 4. What factors affect metals recycling from Australian buildings?

- What is the proportion of different metals in buildings and urban infrastructure that you can recover?
- What factors affect the accessibility of metals in different types of structures?
- What factors affect decisions about how and where to recycle or dispose of metals?
- What factors do you think will affect metals recycling capacity from buildings and urban infrastructure in the future?
EXPLANATORY STATEMENT

Project Title: ‘Metal stocks of buildings and urban infrastructure in Australian cities’

THIS INFORMATION SHEET IS FOR YOU TO KEEP.

My name is Dan Santos and I am researching organisations involved in the metals recycling from buildings and urban infrastructure in Australian on behalf of CSIRO and Monash University. This work forms a part of a larger collaborative research program called ‘Wealth from Waste’ which investigates the feasibility of developing more advanced metals recycling in Australia. The program is funded by CSIRO and involves collaboration between four Australian Universities and Yale University in the USA. This specific project on metals recycling from buildings and urban infrastructure is being conducted through Monash University.

You are invited to take part in this study. Please read this Explanatory Statement in full before making a decision.

THE AIM OF THIS RESEARCH

THE AIM OF THIS RESEARCH PROJECT IS TO OBTAIN FURTHER UNDERSTANDING THE STOCKS OF METALS CONTAINED IN DIFFERENT TYPES OF BUILDINGS AND URBAN INFRASTRUCTURE. SPECIFIC AIMS ARE AS FOLLOWS:

1. To characterize what metals are found in different types of buildings and infrastructure
2. To develop a proxy tool to estimate the quantities of metals in different types of buildings and urban infrastructure
3. To identify the range of factors that affect the recycling of metals from buildings and urban infrastructure

Why were you chosen for this research?

As part of this research we are conducting interviews with a wide range of organisations involved the construction and demolition of buildings and urban infrastructure in Australian cities. Your contact details were obtained from your website.

POSSIBLE BENEFITS

This project offers you the opportunity to reflect on issues concerning metals recycling from buildings and urban infrastructure in Australia, and to share your perspectives and knowledge on these issues. The overarching aim of the research is to identify strategies that could be implemented at a national level to foster the development of more advanced metals recycling in Australia.

WHAT DOES THE RESEARCH INVOLVE?

Your participation in this research will involve an audio recorded conversation with me or a co-researcher either at your office or at a public location of your choosing. There is a possibility of a follow-up interview for further discussion should you consent to it. The audio recording will be used only to assist preparation of a transcript of the interview, which will be provided to you after the interview for verification and or correction, as required.

HOW MUCH TIME WILL THE RESEARCH TAKE?

The interview will take no longer than one hour.

PAYMENT

There will be no payment involved in this research.

YOU CAN WITHDRAW FROM THE RESEARCH.

Being in this study is voluntary and you are under no obligation to consent to participation. If you do consent to participate, you can refuse to answer any question if you do not feel comfortable and may
withdraw from further participation at any stage. However, you will only be able to withdraw data prior to your approval of the interview transcript.

CONFIDENTIALITY

The findings of this research will be published in reports made available on websites and in journal articles and conference presentations, but in all publications arising from this research you will not be identifiable. Pseudonyms will be used in any published material and your personal details will be obscured or altered after the interview is transcribed.

STORAGE OF DATA

Data collected will be stored in accordance with Monash University regulations, kept on University premises, in a locked filing cabinet for five years after the completion of the thesis.

RESULTS

If you would like to be informed of the aggregate research finding, you are encouraged to contact the chief investigator Dr Xuan Zhu, at xuan.zhu@monash.edu or 03 9902 0056. The findings will be accessible from 2016.

CONTACT

If you would like to contact the researchers about any aspect of this study, please contact me at

Dan Santos
Building 20, Chancellors Walk, W826
Monash University
Clayton, Victoria 3800
Tel: +61 3 9905 0585
Email: dan.santos@monash.edu

If you have any complaint concerning the manner in which this research is being conducted, please contact (Project Number CF14/1787 - 2014000903):

Executive Officer
Monash University Human Research Ethics Committee (MUHREC)
Building 3e, Room 111
Research Office
Monash University VIC 3800
Tel: +61 3 9905 2052
Fax: +61 3 9905 3831
Email: murhrec@monash.edu

Yours Sincerely,

Dan Santos
APPENDIX B: INTERVIEW QUESTION GUIDE AND EXPLANATORY STATEMENT (E-WASTE)

Topic 1. What types of organisations are involved in collection and reprocessing of scrap metal, mobile phones, handheld batteries and computers and televisions from Australian cities?
   - How would you describe the primary objectives of this organisation?
   - What type of activities is this organisation involved in?
   - What range of materials or product types does this organisation collect or process?
   - How is your organisation positioned in the supply chain for recycled metals?
   - How large is the organisation in terms of a) numbers of people employed, and b) quantities of materials collected?
   - What type of facilities or equipment are used by this organisation?
   - What are the ownership arrangements and who are the main beneficiaries of this organisation (e.g. shareholders etc)?

Topic 2. What are the more significant incentives and disincentives influencing the involvement of different types of organisations in collection systems?
   - What aspects of law or government policy influence your capacity to collect or process materials?
   - What are the main government organisations that you interact with?
   - Is your organisation required to comply with forms of licensing or standards certification?
   - What aspects of the broader economic environment influence your organisation’s incentive or capacity to collect or process materials?
   - Do public attitudes towards recycling affect your organisation’s activities?

Topic 3. What factors most strongly influence the effectiveness of collection systems?
   - What factors are most important to the effectiveness of your operations, e.g. regulation, financial, other?

Topic 4. What are the spatial and logistical characteristics of systems for collection and reprocessing of used electronics, handheld batteries and scrap metal in Australia?
   - What are the main logistics involved in your organisation’s collection operations?
   - What is the geographical extent of your organisation’s operations?
   - What are the geographical limits to your organisation’s operations?

Topic 5. What information is collected relating to quantity and volume of used electronics, handheld batteries and scrap metal currently collected for reprocessing?
   - What sort of records do you keep about your organisation’s activities?
   - What aspects of your record keeping are mandatory and what are voluntary?
   - What obligations do you have to report the data you keep to a government agency?
EXPLANATORY STATEMENT

Project Title: ‘Wealth from Waste: Mapping, characterising and evaluating collection systems and organisations’

THIS INFORMATION SHEET IS FOR YOU TO KEEP.

My name is Dan Santos and I am researching organisations involved in the collection and reprocessing of used metals in Australia on behalf of CSIRO and Monash University. This work forms a part of a larger collaborative research program called ‘Wealth from Waste’ which investigates the feasibility of developing more advanced metals recycling in Australia. The program is funded by CSIRO and involves collaboration between four Australian Universities and Yale University in the USA. This specific project on collection systems and organisations is being conducted through Monash University.

You are invited to take part in this study. Please read this Explanatory Statement in full before making a decision.

THE AIM OF THIS RESEARCH

THE AIM OF THIS RESEARCH PROJECT IS TO BROADEN UNDERSTANDING OF THE RANGE OF ORGANISATIONS INVOLVED IN COLLECTION AND REPROCESSING OF USED METALS, SPECIFICALLY FOCUSING ON BULK SCRAP METAL, COMPUTERS AND TVs, MOBILE PHONES AND HAND HELD BATTERIES. SPECIFIC AIMS ARE AS FOLLOWS:

1. to identify and characterise the range of organisations involved in collection and reprocessing of scrap metal, mobile phones, hand held batteries and computers and televisions from Australian cities
2. to identify incentives and disincentives for involvement of different types of organisations in collection systems
3. to identify factors that most strongly influence the effectiveness of collection systems
4. to identify and characterise the spatial and logistical dimensions of systems for collection and reprocessing
5. to generate data that will contribute to stock and flow modelling of waste metals collection in Australia

WHY WERE YOU CHOSEN FOR THIS RESEARCH?

As part of this research we are conducting interviews with a wide range of organisations involved in the collection and reprocessing of used metals in Australia. Your contact details were obtained from your website.

POSSIBLE BENEFITS

This project offers you the opportunity to reflect on the position of your own organisation within the larger context of metals recycling in Australia and to share your perspectives on the factors that either facilitate or hinder your activities. The overarching aim of the research is to identify strategies that could be implemented at a national level to improve the effectiveness of collection and reprocessing activities in Australia.

WHAT DOES THE RESEARCH INVOLVE?

Your participation in this research will involve an audio recorded conversation with me or a co-researcher either at your office or at a public location of your choosing. There is a possibility of a follow-up interview for further discussion should you consent to it. The audio recording will be used only to assist preparation of a transcript of the interview, which will be provided to you after the interview for verification and or correction, as required.
HOW MUCH TIME WILL THE RESEARCH TAKE?

The interview will take approximately one hour.

PAYMENT

There will be no payment involved in this research.

YOU CAN WITHDRAW FROM THE RESEARCH.

Being in this study is voluntary and you are under no obligation to consent to participation. If you do consent to participate, you can refuse to answer any question if you do not feel comfortable and may withdraw from further participation at any stage. However, you will only be able to withdraw data prior to your approval of the interview transcript.

CONFIDENTIALITY

The findings of this research will be published in reports made available on websites and in journal articles and conference presentations, but in all publications arising from this research you will not be identifiable. Pseudonyms will be used in any published material and your personal details will be obscured or altered after the interview is transcribed.

STORAGE OF DATA

Data collected will be stored in accordance with Monash University regulations, kept on University premises, in a locked filing cabinet for five years after the completion of the thesis.

RESULTS

If you would like to be informed of the aggregate research finding, you are encouraged to contact the chief investigator Dr Ruth Lane, at ruth.lane@monash.edu or 03 99052937. The findings will be accessible from 2016.

CONTACT

If you would like to contact the researchers about any aspect of this study, please contact me at

Dan Santos
Building 11, E756B
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Clayton, Victoria 3800
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Email: dan.santos@monash.edu

If you have any complaint concerning the manner in which this research is being conducted, please contact (Project Number CF14/1787 - 2014000903):

Executive Officer
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Building 3e, Room 111
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Tel: +61 3 9905 2052
Fax: +61 3 9905 3831
Email: murhrec@monash.edu

Yours Sincerely,

Dan Santos
APPENDIX C: REGULATORY FRAMEWORK FOR METALS IN BUILDINGS IN AUSTRALIA

STAGE 1 - SOURCING SCRAP METAL

Commonwealth legislation and policies

- **Customs Act 1901(Cth) and the Customs Tariff (Anti-Dumping) Act 1975 (Cth).**
- National Environment Protection (Movement of Controlled Waste Between States and Territories) Measure 2010
- National Environment Protection (National Pollutant Inventory) Measure 1998
- **National Waste Policy 2009**

Victorian legislation and policies

- Environment Protection Act 1970 (Vic)
- Waste Management Policy (Movement of Controlled Waste between States and Territories)
- Environment Protection (Industrial Waste Resource) Regulations 2009 (Vic) – see Table below for a summary of legislation imposing landfill levies across all States and Territories for 2015/16:

<table>
<thead>
<tr>
<th>STATE/TERRITORY and RELEVANT LEGISLATION</th>
<th>LEVY FOR METROPOLITAN AREAS</th>
<th>LEVY FOR NON-METROPOLITAN/ RURAL AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment Protection Act 1970 (s 50S, Sched DA) and <strong>Environment Protection (Industrial Waste Resource) Regulations, 2009</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection of the Environment Operations Act 1997 (NSW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Queensland</strong></td>
<td>Nil.</td>
<td>Nil.</td>
</tr>
<tr>
<td>Waste Reduction and Recycling Act 2011 (Qld)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Management and Pollution Control Act 1994 (Tas).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Western Australia
Inert waste: $40 per tonne
Putrescible waste: $55 per tonne.
Source:

Northern Territory
Waste Management and Pollution Control Act (NT) Nil.
Source:

Australian Capital Territory
Waste Minimisation Act 2001 (ACT) Nil.
Source:

STAGE 2 - PROCESSING SCRAP METAL

Commonwealth legislation and policies

- National Waste Policy 2009
- Hazardous Waste (Regulation of Exports and Imports) Act 1989 (Cth)
- National Environment Protection (Movement of Controlled Waste Between States and Territories) Measure 2010
- National Environment Protection (National Pollutant Inventory) Measure 1998
- Sustainable Procurement Guide (Cth) 2013

Victorian legislation and policies

- Efficient Government Buildings Program (Vic)
- Victoria’s Future Industries – Construction Technologies

Voluntary schemes

- Green Star (Green Building Council of Australia)

STAGE 3 - PROCURING METAL

Commonwealth legislation and policies

- National Waste Policy 2009
- Uniform Building Code of Australia (Australian Building Codes 2009) and National Construction Code (NCC)
  - ‘CodeMark’ building product certification scheme and the mandatory (ABCB)
  - ‘WaterMark’ plumbing and drainage product certification scheme (ABCB).

- Customs Act 1901(Cth) and the Customs Tariff (Anti-Dumping) Act 1975 (Cth).
- Sustainable Procurement Guide (Cth) 2013
Victorian legislation and policies

- Efficient Government Buildings Program (Vic)
- Victoria’s Future Industries – Construction Technologies
- Victorian Government Office Accommodation Guidelines 2007 (procurement guidelines)

Voluntary schemes

- Green Star (Green Building Council of Australia)
- USA - Leadership in Energy and Environmental Design (LEED)
- UK - Building Research Establishment Environmental Assessment Method (BREEAM)
APPENDIX D: REGULATORY FRAMEWORK FOR E-WASTE IN AUSTRALIA

STAGE 1 – END OF USE AND DISPOSAL

Commonwealth legislation and policies

- National Waste Policy 2009
- Product Stewardship Act 2011 (Cth)
- Product Stewardship (Televisions and Computers) Regulations 2011
- Competition and Consumer Act 2010 (Cth)

State legislation and policies

- Environment Protection Act 1970 (Vic) (and similar in other States and Territories)
- Sustainability Victoria Act 2005
- Crimes Act 1958 (Vic) (and similar in other States and Territories)
- Second-Hand Dealers and Pawnbrokers Act 1989 (Vic) (and similar in other States and Territories)

Voluntary schemes

- Victoria - Environment and Resource Efficiency Plans (terminated ion 2014)
- Sustainability Victoria - voluntary household programs: “Detox Your Home” (for household chemicals) “Battery Back” (for used household batteries), “Byteback” (computers and peripherals) and “Paintback” (paint)
- Mobile Muster – Australian Mobile Telecommunications Association voluntary industry product stewardship take back scheme for mobile phones.
- ISO 14001 Specification for Environmental Management System

STAGE 2 – COLLECTION PHASE

Commonwealth legislation and policies

- National Waste Policy 2009
- Product Stewardship Act 2011 (Cth)
- Product Stewardship (Televisions and Computers) Regulations 2011

State legislation and policies

- Sustainability Victoria Act 2005

Voluntary schemes

- Victoria - Environment and Resource Efficiency Plans (terminated ion 2014)
- Sustainability Victoria - voluntary household programs: “Detox Your Home” (for household chemicals) “Battery Back” (for used household batteries), “Byteback” (computers and peripherals) and “Paintback” (paint)
- Mobile Muster – Australian Mobile Telecommunications Association voluntary industry product stewardship take back scheme for mobile phones.


**EU legislation**

### STAGE 3 – SORTING AND DISASSEMBLY

#### Commonwealth legislation and policies
- National Waste Policy 2009
- Product Stewardship Act 2011 (Cth)
- Product Stewardship (Televisions and Computers) Regulations 2011
- Competition and Consumer Act 2010 (Cth)

#### State legislation and policies

<table>
<thead>
<tr>
<th>State/territory</th>
<th>Legislation</th>
<th>Related policy strategies/plans</th>
</tr>
</thead>
</table>
| Vic             | • Environment Protection Act 1970  
• Environment Protection (Scheduled Premises and Exemptioons) Regulations 2007  
• Environment Protection (Industrial Waste Resource) Regulations 2009  
• Sustainability Victoria Act 2005  
• Dangerous Goods Act 1985 (Vic)  
• Dangerous Goods (Transport by Road and Rail) Regulations 2008  
Metropolitan Waste and Resource Recovery Strategic Plan (March 2009)  
| NSW             | • Protection of the Environment Operations Act 1997  
| Qld             | • Waste Reduction and Recycling Act 2011  
• Environment Protection Act 1994  
• Environment Protection Regulation 2008  
| SA | • Environment Protection Act 1993  
• Zero Waste SA Act 2004 | • Environment Protection (Waste to Resources) Policy  
• South Australia’s Strategic Plan  
• South Australia’s Waste Strategy 2011-2015 |
|---|---|---|
| WA | • Waste Avoidance and Resource Recovery Act 2007  
• Waste Avoidance and Resource Recovery Levy Act 2007  
• Waste Avoidance and Resource Recovery Levy Regulations 2008  
• Environment Protection Act 1986 | • Western Australian Waste Strategy: “Creating the Right Environment” |
| Tas | • Environmental Management and Pollution Control Act 1994  
• Environmental Management and Pollution Control (Waste Management) Regulations 2010  
• Environmental Management and Pollution Control (Controlled Waste Tracking) Regulations 2010 | • Tasmanian Waste and Resource Management Strategy |
| ACT | • Environment Protection Act 1997  
• Clinical Waste Act 1990  
• Waste Minimisation Act 2001  
• Litter Act 2004  
• Dangerous Substances Act 1990 | • ACT Waste Management Strategy 2011-2025 |
| NT | • Waste Management and Pollution Control Act | |

**STAGE 4 – RESALE, REUSE and MATERIALS RECYCLING**

**Commonwealth legislation and policies**

- National Waste Policy 2009
- Customs Act 1901(Cth) and the Customs Tariff (Anti-Dumping) Act 1975 (Cth).
- National Environment Protection (Movement of Controlled Waste Between States and Territories) Measure 2010
- National Environment Protection (National Pollutant Inventory) Measure 1998

**State legislation and policies**

- As for Stage 1 above
International law

- Stockholm Convention on Persistent Organic Pollutants
- Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
- Vienna Convention for the Protection of the Ozone Layer and Montreal Protocol
- on Substances that Deplete the Ozone Layer
- United Nations Framework Convention on Climate Change and the Kyoto Protocol
- World Trade Organisation rules