Sustainability and the Waste Management Hierarchy

A discussion paper on the waste management hierarchy and its relationship to sustainability

A discussion paper prepared for EcoRecycle Victoria
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1. Introduction

The waste management hierarchy is a concept that promotes waste avoidance ahead of recycling and disposal. The shortened version of the hierarchy, 'reduce reuse recycle' is frequently used in community education campaigns, and has become a well-recognised slogan for waste reduction and resource recovery.

The purpose of this paper is to review the continuing relevance of the hierarchy as a guiding principle, particularly in the context of:

- Sustainability goals, which need to consider complex relationships between impacts (such as waste and energy) and between systems (physical, social and economic systems) rather than focusing on single issues;
- The rapid development of new technologies for waste recovery, such as gasification and commercial composting; and
- New concepts and trends in product policy, including Product Stewardship, Life Cycle Assessment, eco-innovation and eco-efficiency (i.e. dematerialisation).

This paper sets out to discuss or answer the following questions:

1. Is there a practical definition of sustainability or a set of principles that can be used to guide decision-making on waste reduction and resource recovery?
2. How is the concept of a waste hierarchy currently being used to guide decision making on waste reduction and resource recovery?
3. Does the waste hierarchy need to be redefined in the light of current thinking on sustainability?
4. How can the waste hierarchy be used to promote more sustainable systems of production and consumption in Victoria?

The theme of the paper is *sustainability* and how the hierarchy could be reinterpreted or re-applied in a more focused way to deliver socio-environmental outcomes that are preventative in nature.

Significant change within a relatively short timeframe is essential if we are to achieve a sustainable future. This means that society can no longer continue with the 'incremental change' approach. There is potential for a more sophisticated role for the hierarchy as a way of shifting to more sustainable systems of production and consumption.

2. Defining Sustainability

Sustainability has been defined as the goal of sustainable development, which is 'types of economic and social development that protect and enhance the natural environment and social equity' (Diesendorf 2000: 23).

The term 'sustainable development' entered the public debate after the World Commission on Environment and Development published their landmark report, Our Common Future, in 1987. It was defined in this report as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987: 43). Our Common Future identified a series of social and ecological challenges that required a global response, including unsustainable patterns of industrial development. It recommended that:

> In general, industries and industrial operations should be encouraged that are more efficient in terms of resource use, that generate less pollution and waste, that are based on the use of renewable rather than non-renewable resources, and that minimize irreversible adverse impacts on human health and the environment (WCED 1987: 213).

Many writers and policy makers since Our Common Future have attempted to further define sustainability and to develop practical strategies. This paper is not intended to be an exhaustive overview of the literature, however some of the key ideas are discussed below. In Beyond the Limits, a sustainable society is defined as 'one that can persist over generations, one that is far-seeing enough, flexible enough and wise enough not to undermine either its physical or its social systems of support' (Meadows et al 1992: 209). The authors note that social sustainability requires that living standards are adequate and secure for everyone. In order to be physically sustainable, society's material and energy throughputs need to meet economist Herman Daly's three conditions:

- Its rates of use of renewable resources do not exceed their rates of regeneration;
- Its rates of use of non-renewable resources do not exceed the rate at which sustainable renewable substitutes are developed; and
- Its rates of pollution emission do not exceed the assimilative capacity of the environment (cited in Meadows et al 1992: 209).

Other writers in recent years have highlighted the fact that 'true' sustainability will require significant increases in the efficiency of resource use (often called 'eco-efficiency'). Von Weizsacker, Lovins and Lovins (1997) present compelling evidence that a factor four reduction in resource use is both necessary and achievable with technologies that already exist. The Dutch Government's program for Sustainable Technology Development estimated the required improvement in eco-efficiency is at least 20. It also demonstrated that this was possible using future visions to derive the R&D agenda of today (Volenbroek 2002: 216). Hall (2002: 195) argues that while the introduction of innovation is never straightforward, 'sustainable development innovation' is even more complex because it faces resistance from a broad range of stakeholders. It involves consideration of 'not only technological and environmental considerations, but also the dynamics of social change'.

John Elkington introduced the term 'triple bottom line sustainability' in his book Cannibals with Forks in 1998. He argues that businesses need to address the triple bottom line - economic prosperity, environmental quality and social justice. The principle (and language) of triple bottom line sustainability is increasingly being adopted by governments and corporations. At a more local level, the Victorian Government introduced a series of principles into the Environment Protection Act (November 2000) that are designed to provide a framework for the administration of the Act. These principles include the fact that *sound* environmental practices 'should require the effective integration of economic, social and environmental considerations in decision-making processes with the aim to improve community well-being and the benefit of future generations.'

Perhaps one of the most fundamental conclusions about sustainability is that our current patterns of production and consumption are unsustainable. Hardin Tibbs has described what he sees as 'the crisis of unsustainability', and notes that there will need to be a transitional period while current patterns of unsustainability are replaced by a future condition of sustainability (Tibbs 1999).

In their book Natural Capitalism, Paul Hawken, Amory Lovins and Hunter Lovins argue that the earth's natural capital, in the form of products such as timber and oil, and services such as water storage and clean air, is diminishing at an alarming rate:

> Humankind has inherited a 3.8-billion-year storage of natural capital. At present rates of use and degradation, there will be little left by the end of the next century. This is not only a matter of aesthetics and morality; it is of the utmost practical concern to society and all people. Despite reams of press about the state of the environment and rafts of laws attempting to prevent further loss, the stock of natural capital is plummeting and the vital life-giving services that flow from it are critical to our prosperity. (Hawken et al 1999: 3)

Donella Meadows and her co-authors in Beyond the Limits support this view. They argue that human consumption of many essential resources and generation of many pollutants have already surpassed rates that are physically sustainable, and that we need to drastically increase the efficiency with which we use materials and energy (xv - xvi). Meadows et al see recycling as an essential tool in achieving sustainability:

> Separating and recycling materials after use is a step toward sustainability. It begins to move materials through the human economy the way they move through nature - in cycles. In nature the waste from one process becomes an input to another process. Whole sectors of ecosystems, particularly in the soils, work to take nature's waste materials apart, separate them into usable pieces, and send them back into living creatures again. The modern human economy is finally developing a recycling sector too. (82-83)

The authors of Natural Capitalism argue that we need a new industrial revolution; one that moves us to a new industrial system that values human and natural capital as well as conventional economic values. They propose four strategies for natural capitalism:

- Radical resource productivity –using resources more efficiently;
- Biomimicry - eliminating waste through closed cycles and elimination of toxicity;
- Service and flow economy – a shift from an economy based on products to one based on services; and
- Investing in natural capital – reversing environmental destruction through investment in sustaining and restoring natural capital (Hawken et al 1999: 10-11).

At a policy level, the European Commission (EC) through its Environment Directorate-General, presents a relatively strong view about the critical importance of sustainable development and the implications for Europe and beyond. While EC thinking on sustainability is consistent with the Brundtland definition, the focus is on policy content and the process of transforming the concept into an operational reality.

> "Sustainable development must be placed at the core of the mandate of all policy makers. Better policy integration, relying on systematic and transparent review of the costs and effects of different options, is crucial, so that different policies reinforce each other, trade-offs are made by informed decisions, and environmental and social objectives are met at least economic costs. Openness will also facilitate better dialogue between stakeholders with divergent interests, paving the way for a broad consensus on solutions and their implementation." (European Commission 2001:3)

Another key issue raised in the EC paper is the connection between production and consumption within the context of sustainable development. The paper stresses the growing momentum behind initiatives concerned with greater consumer education, and the cultural change necessary to fully exploit the sustainability potential of smart technologies (European Commission 2001:3).

What is consistent across much of the literature on sustainability and sustainable development, is the notion of a dynamic concept that is evolving as new knowledge is developed. The broadness and all-encompassing nature of sustainability demands a high degree of flexibility that can process and operationalise new data and information across multiple sectors, disciplines and geographies. Philip Sutton from Green Innovations offers some pertinent observations about sustainability and its attributes in this regard, arguing that 'sustainability must be a destination, not just a journey'. More importantly, Sutton says, 'that treating a sustainable state as a destination doesn't mean that society cannot revise or refine its idea of what sustainability is at a future date (see www.green-innovations.asn.au)

In summary:

- **Our current rates of resource consumption and pollution are unsustainable because they exceed the rates at which resources can be regenerated and wastes assimilated by the Earth's natural systems. Society is depleting its stocks of 'natural capital' at an unsustainable rate.**

- **Sustainability requires radical new ways of thinking to achieve significant changes in production and consumption systems. This includes a more sophisticated understanding of complex interactions between different environmental impacts, and looking for step change innovation rather than incremental change.**

- **Sustainability must address social issues such as access, equity and justice along with economic and environmental sustainability i.e. the new triple bottom line for business and government.**

- **Key strategies for sustainability include radical improvements in eco-efficiency, the closing of material and waste cycles (eliminating waste) and a shift from products to services i.e. dematerialisation.**

3. The Waste Hierarchy

The waste management hierarchy can be traced back to the 1970s, when the environment movement started to critique the practice of disposal-based waste management. Rather than regarding 'rubbish' as a homogenous mass that should be buried, they argued that it was made up of different materials that should be treated differently – some shouldn't be produced, some should be reused, some recycled or composted, some should be burnt and others buried (Schall 1992).

As a concept or principal, the hierarchy makes sense in a way that is difficult to oppose. It echoes approaches that are widespread in human health and medicine, i.e. prevention is better than cure. Most would agree that it is more effective to avoid problems from the outset, than to invest in reactive solutions once the problem has presented. The parallels in human health and environmental protection are similar and supported by considerable scientific evidence and knowledge.

Within the context of industrial environmental management in the 1980s and 1990s, end-of-pipe responses were increasingly viewed as ineffective in their long-term impact. Cleaner Production represents one approach that helped inform the development of the hierarchy. Together with Cleaner Production, there emerged other related terms and concepts such as source reduction and P2 or Pollution Prevention – the American equivalent of Cleaner Production. The essence of these approaches is characterised by a need to avoid, eliminate, prevent or significantly reduce the causes of environmental problems, as opposed to managing the impacts, wastes and emissions arising further down the product or service life cycle. This suggests a fundamental change in the nature of environmental interventions in terms of rationale, timing and specific approach.

Although terminology can vary, a simple description of environmental attributes and outcomes of the waste hierarchy is outlined below:

Goal	Attribute[1]	Outcomes
Reduce	Preventative	Most desirable
Reuse	Predominantly ameliorative Part preventative	↑
Recycle	Predominantly ameliorative Part preventative	↕
Treatment	Predominantly assimilative Partially ameliorative	↓
Disposal	Assimilative	Least desirable

In Victoria, the hierarchy is embedded in the Victorian Environment Protection Act, specifically stating that wastes should be managed in accordance with the following order of preference: avoidance, re-use, re-cycling, recovery of energy, treatment, containment and disposal. EcoRecycle Victoria through its various industry, government and community programs, is the key agency for developing and facilitating strategies that help operationalise the hierarchy in relation to solid waste. Their role has been a major influence in moving certain industry sectors and specific companies away from simply transporting and managing waste, and closer to resource recovery and associated market development programs.

[1] Whereas a *preventative* approach seeks to eliminate or avoid the waste from the outset, an *ameliorative* process can only ever minimise or shrink the problem. Finally, an *assimilative* mode is underpinned by the view that the wider ecosystem can continue absorbing and integrating the waste into a larger system.

Hirschhorn, Jackson and Baas (1993) provide a concise description of the transition in thinking from end-of-pipe to more preventative models and the more positive and affirmative role that precautionary strategies can achieve:

> 'A multitude of terms and phrases define and describe the emerging preventative environmental paradigm. These terms include pollution prevention, source reduction, and waste reduction. Waste minimisation, toxics use reduction, and clean or cleaner technology. In theory, the newer sets of terms refer to forms of preventative action that shrink the fundamental causes of environmental problems. Certainly, the newer terms are becoming increasingly more popular than the more traditional phraseology of environmental protection such as pollution control, waste management, environmental control and waste disposal. These older actions are characterised by their attempt to solve environmental problems by reacting to the effects of pollutants.'(1993: 125-143)

While Hirschorn et al acknowledge the more radical commercial and industrial implications of avoidance and prevention, they also note the need for substantial changes in how products, services and associated materials are consumed:

> 'Secondly, it is necessary to see the importance of addressing materials. Technology application and the production of goods and services depends on using materials. The roots of all pollution ultimately devolve to decisions on what raw materials to extract and use and what synthetic or engineered materials are manufactured to make, transport, and package products. The problems of wastes and pollutants are directly related to the materials cycle. Hence, implementation of the prevention paradigm can be through changes in the materials cycle and, therefore, it is no surprise that environmentalists have increasingly focused on toxics-use reduction.' (1993: 136).

Hirschhorn et al also demonstrate a high degree of realism and recognise that a hierarchy of prevention, necessarily requires upheaval and organisational change that is not always desirable or appealing to companies that have invested heavily in conventional environmental management systems and other end-of-pipe strategies.

It would be accurate to conclude that the hierarchy is an important element guiding the formulation of waste related policies and programs and regulations in Australia and overseas. It should also be noted however, that there are two schools of thought on the hierarchy and how it should be interpreted within an integrated waste management framework:

- One interpretation is that integrated waste management is a 'menu of options' and there is no such thing as a good or bad technology option. Each is equally valid depending on the circumstances;
- The other interpretation is that the hierarchy should be strictly followed, i.e. we should maximise the amount of waste prevented at source, then maximise the amount recycled or composted, and only then burn or bury the rest (Schall 1992).

In Australia, overall implementation of the hierarchy has been patchy, with most effort to date focussed on recycling and composting. The degree to which Australian producers of goods and services have engaged with upper levels of the hierarchy is negligible. Preventative programs centred on waste avoidance are piecemeal and at best tinkering with minor efficiency gains rather than wholesale reconfiguration. Similarly, there is little evidence of widespread reuse, refurbishment or remanufacturing activity that can be classed as anything other than cottage-based or boutique in its orientation. Even though there are noteworthy Australian examples of remanufacturing, the reality is that national initiatives are limited. Even though Australia can boast about Fuji Xerox being a world-class remanufacturer, such case studies are insufficient to demonstrate the success of public policies directed at achieving higher levels of waste avoidance and reduction.

A major barrier to implementation of the hierarchy is the fact that solid waste managers have very little control over the generation of waste and therefore have limited capacity to achieve source reduction. Designers, engineers and managers in industry make decisions about what is manufactured, processed or constructed, and how this is done, and therefore the amount and type of waste generated. In order to be effective therefore, the waste hierarchy needs to be tackled by working in two different systems – the waste management system and the production system (Schall 1992).

The momentum internationally and locally, is building around the goal of resource-use efficiency and the notion of doing more with less i.e. eco-efficiency. A key driver behind these approaches is the need to decouple economic growth from negative environmental impacts. Underpinned by life cycle assessment methodologies using quality data, the goal of resource-use efficiency has the potential to be well served by the hierarchy, especially if the emphasis within the hierarchy can shift upwards towards waste prevention and reduction.

In summary:

- **The waste hierarchy is extensively used by governments, industry, educators and environment groups as a guiding principle for waste policy and programs.**
- **Interpretations of the hierarchy vary, with some governments and NGOs interpreting it strictly as a 'most preferred to least preferred' hierarchy, while others in government and industry would prefer an integrated approach that includes a range of waste management options without a constraining hierarchy definition.**
- **A barrier to implementation of the hierarchy is that solid waste managers in government and industry have little control over production decisions that influence waste generation, particularly in the absence of regulation.**
- **There is increasing recognition internationally of the need to focus more intensively on preventative strategies rather than waste reduction or recovery. Most of the current effort is still on recycling programs, which are important but not as effective as prevention or reduction strategies in achieving sustainability.**

The next section examines links between the waste hierarchy and sustainability in more detail.

4. Waste and Sustainability

'Waste' includes both products that have reached the end of their useful life and by-products of other processes such as manufacturing, commerce, construction and demolition. The waste we see at the end of a product's life is only the tip of the iceberg. The actual waste generated at that point is a fraction of the materials used to process and transport the product throughout its life cycle. For example, a gold ring weighing 10 grams has generated approximately 3 tonnes of waste on a life cycle basis (von Weizsacker at al 1997: 242). This is sometimes called the 'ecological rucksack' or the 'ecological footprint' of a product.

The other important issue is that every product 'embodies' all of the impacts that have already occurred throughout its life cycle, for example:

- The impacts of mining or harvesting raw materials – land degradation, emissions etc;
- The impacts of manufacturing – use of materials and energy, air and water emissions, solid wastes etc; and
- The impacts of transporting raw materials and products to end markets.

For the purpose of this discussion, these impacts will be referred to as 'Embodied Environmental Value' (EEV).

Waste management itself also has environmental impacts, such as the air emissions from garbage and recycling trucks collecting wastes, and the water used in reprocessing (Appendix Table 1).

It also has social and economic impacts (Appendix Table 1). Any consideration of a 'waste hierarchy' therefore needs to consider the impacts of each waste management option, as well as any avoided impacts throughout the life cycle (e.g. from substituting recycled material for virgin material).

The key sustainability principles that need to be applied to waste management can be taken from *Natural Capitalism*, i.e. radical resource productivity and Biomimicry (i.e. eliminating waste through closed cycles).

As mentioned earlier many writers and policy makers have highlighted resource use efficiency as an essential step in achieving sustainability. Different conclusions have been reached about the required improvement in resource efficiency, ranging from a factor four improvement (75% reduction) to a factor twenty improvement (a ninety-five percent reduction). Related but also featuring its own particular attributes, 'Biomimicry' refers to lessons that can be learnt from nature, in this case the fact that in nature nothing is wasted. The waste from one process becomes raw material for another in continuous closed cycles. In human terms this can be achieved through recycling and composting.
If the hierarchy is to be logically and coherently linked to achieving sustainability, then a reinterpretation is necessary.

In its most simple form there needs to be an organisational and technical shift that moves from a hierarchy dominated by resource recovery to a hierarchy of prevention or avoidance. This is not radical nor is it academic. Indeed it mirrors industrial environmental management thinking of the 80s and 90s whereby end-of-pipe responses were viewed as futile in favour of upstream solutions characterised by source reduction and cleaner production.

Implementation of the waste hierarchy needs to consider several key principles:

1. Avoidance and reduction should always be the preferred options, because they avoid impacts across the entire product life cycle, including disposal. In sustainability terms they enable us to ‘do more with less’ and radically improve resource use efficiency.
2. Recovery options should aim to preserve the maximum amount of Embodied Environmental Value (EEV) possible. In sustainability terms we should aim to eliminate waste through closed cycles that maximize the value of materials (in both environmental and economic terms) at all times.
3. Energy recovery should only be used for materials that have no higher end use than to be converted to energy.
4. Selection of recovery options should consider the broader sustainability impacts of each technology, not just their impacts on waste. Other environmental impacts may include greenhouse gas generation, water consumption and waterborne wastes. Social and economic impacts also need to be considered.

The second principle on maximising environmental value is supported by the Life Cycle Assessment on Packaging and Paper Waste Management (Grant et al) which found that most of the environmental benefit of recycling derived from the replacement of virgin material with recycled material. The implication is that closed loop recycling is the most likely to achieve environmental benefits, rather than ‘downcycling’ into lower value products.

The third principle for energy recovery is consistent with the draft *Guideline for Sustainable Energy from Waste Project Development* developed by the Waste Management Association of Australia (WMAA 2001). This proposes a number of principles for energy recovery from waste:

- That a potential fuel source not be irreversibly converted to energy if it still retails a ‘higher’ value as a basic resource material.
- The conversion technology should be as efficient as possible
- The recovery of energy should lead to:

    - A net conservation of resources
    - A reduction of pollutants (especially air including greenhouse gas emissions
    - No unreasonable costs
    - No increased health risks
    - No diminished local amenity.

Ultimately it seems that barriers to an effective hierarchy have less to do with suitable technologies and industrial capabilities, compared to the identification of corporate and institutional barriers. For the hierarchy to operate successfully demands attention across all levels and not just those that appear ‘easy’ or commercially relevant over the short term.

As outlined in section 3, one of the key barriers to implementation of the hierarchy is the need to influence decisions made by different players in the economic system:

- Governments and the waste management industry make decisions about the use of specific waste management options or technologies;
- Designers and managers in the manufacturing and construction industries make production decisions that influence the generation of waste.

In summary:

- **The literature on sustainability supports the continuing relevance of the waste hierarchy as a guiding principle.**
- **However, any interpretation of the waste hierarchy must also take into account broader environmental, social and economic impacts.**
- **Strategies for prevention and reduction are more challenging to current patterns of consumption and production, but ultimately more effective in shifting to sustainability.**

The following case study of clothes washing may help to illustrate the benefits of using the waste hierarchy in a sustainability framework to guide decision-making.

Case Study in Sustainability Thinking – Sustainable Clothes Washing

The conventional recovery system for clothes washing machines in Australia is shredding to recover the metal content, and disposal of the remaining material ('shredder fluff').

A conventional interpretation of the waste hierarchy would lead to the following strategies being considered:

- Can we eliminate unnecessary components or reduce the weight of components i.e. can we maximise strength and/or performance to weight ratios **(Reduce)**
- Can we design components and the overall appliance to extend product life by avoiding faults, breakdowns and other problems that may result in premature disposal? **(Reduce)**
- Can we design for remanufacture so that components from old machines can enjoy a second life in another appliance? **(Reuse)**
- Can we design for recycling and incorporate recycled and recyclable materials? **(Recycle)**
- Can we design for disassembly and recyclability to recover materials from obsolete appliances? **(Recycle)**
- Can we establish take-back, disassembly and recycling programs for obsolete appliances? **(Recycle)**

A sustainability framework opens up new opportunities for step change innovation, rather than incremental improvement or capture of the 'low hanging fruit'. The focus would shift to eco-efficiency and innovation. For example:

- Do we really need washing machines, or just a way of keeping clothes clean? We could consider alternative fibres that don't need washing **(Avoidance)**
- Can we develop a completely new technology for cleaning clothes that has a much lower environmental impact, such as microwave cleaning? **(Reduction)**
- Can we shift from a product to a service? For example, the manufacturer could lease machines to consumers, and charge per wash, or provide a low cost pick up clothes washing service. **(Reduction)**
- Can we design machines for more effective remanufacturing, and establish lease and take-back systems similar to those currently in place for office equipment? **(Reuse)**
- Can we establish product stewardship programs that establish closed loop programs and eliminate waste from washing machines? **(Recycle)**
- Can we eliminate or significantly minimise related environmental impacts concerned with energy, water and detergent consumption? **(Avoidance and Reduction)**

Under a sustainability framework, system-wide impacts would need to be considered. For example, would a clothes-washing service reduce the impacts of the washing process by using larger and more efficient machines that operate continuously, but add to energy consumption and greenhouse emissions as a result of the transport used to collect clothes? Would the leasing option provide consumers with the latest energy and water-efficient technology, but be too expensive for low-income consumers?

At a policy level, this approach could be facilitated through programs that encourage change at key stages, including:

- product and/or system design
- production
- distribution
- use or consumption
- waste management

In many ways it is about processes that connect social and cultural factors with technical and economic imperatives. The aim is to focus on the function or service as a vehicle for achieving sustainability, rather than locking-in on the eco-redesign of a conventional product. The return to basic principles as a means of stimulating sustainable innovations is absolutely fundamental.

5. Concluding Remarks

A hierarchy, whose levels operate in isolation of each other, serves to undermine the concept itself. Inherent in the hierarchy levels is that they are linked by way of preference and benefit, thus the importance of viewing the entire concept as a model for increasing resource use efficiency and reducing impacts associated with consumption.

A potential solution involves initiatives and tools that are explicitly hierarchy driven yet customised according to a specific product, sector or geographic location. This would then require detailed development of actions and associated metrics to ensure broader sustainability goals are achieved. Tools that can cut through the rhetoric of environmental jargon are vital in delivering real world outcomes that are quantifiable.

For Victorians one of the more significant challenges in realising a sustainable future is the interim process and how it can facilitate the desired outcome. At an international level the research, debate and policy development process is striving to engage with the shift from waste management to resource efficiency, however, this phase clearly presents a major test to the fundamental nature of how society functions. A significant issue is how the concept of sustainability and its sub components like the hierarchy can be developed into programs that are effective across sectors, disciplines, communities and professions. Strategic thinking and creative action ought to become a mainstream approach across all sectors. Intimate stakeholder involvement in policy formulation and implementation, underpinned by good science and enhanced with effective communication and education, represents a vital part of an evolving solution.

Zero waste targets, dematerialisation, life cycle thinking, Ecological Footprint Analysis, Sustainable Consumption, Design for Environment … these tools and approaches are exciting, leading edge and potentially transforming, yet in isolation – as they are generally applied – their overall potency is limited and underdeveloped. Thus the critical importance of strategic policy formulation and the resulting on-ground programs.

EcoRecycle Victoria together with the EPA have a pivotal role to play in advancing the hierarchy as the most effective model by which resource use efficiency can be maximised without constraining responsible economic development. This necessarily requires a stronger and more systematic focus on implementing and communicating the hierarchy, especially initiatives centred on waste avoidance and reduction.

The knowledge and capabilities are certainly resident in Australia and especially Victoria; a key challenge is creating a vehicle to mainstream the goal of sustainability. When this broader framework is in place and inclusive, then sub-themes like effective application of the hierarchy will flow in a more integrated and productive way. Alternatively, the risk of over-investing in recycling may result in applying yesterday's solutions to a future desperate for progressive ideas, actions and leadership.

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APPENDIX

Table 1 Environmental, social and economic impacts and avoided impacts of waste management options

	Environmental impacts (-ve)	Avoided environmental impacts (+ve)	Social Impacts	Economic Impacts
Avoidance	None	Impacts at every stage of the product life cycle – materials, energy, emissions, wastes	Need to change consumption habits	Some products / components may not need to be produced, with potential economic losses to manufacturers
Reduction	None	Impacts at every stage of the product life cycle – materials, energy, emissions, wastes	Cost saving to consumers	Cost saving to the manufacturer
Reuse	Transport – use of fuels, air emissions Cleaning – water, detergents	Impacts of materials processing and product manufacture – materials, energy, emissions, wastes Avoided landfill impacts – air emissions, leachate, visual impact	Need to change consumption habits	New business opportunities to establish collection & refurbishment service
Remanufacturing	Transport – use of fuels, air emissions Manufacture of replacement parts – materials, energy, emissions, wastes Remanufacturing process - energy	Impacts of materials processing and product manufacture – materials, energy, emissions, wastes Avoided landfill impacts – air emissions, leachate, visual impact	Need to change waste disposal patterns, i.e. source separation but does not encourage re-thinking of consumption habits	New business opportunities in remanufacturing
Recycling	Transport – use of fuels, air emissions Reprocessing – energy, water, chemicals, emissions, wastes (contamination, by-products)	Avoided impacts of manufacturing virgin materials - materials, energy, emissions, wastes Avoided landfill impacts – air emissions, leachate, visual impact	Need to change waste disposal patterns, i.e. source separation but does not encourage re-thinking of consumption habits	New business opportunities in reprocessing
Composting (organics)	Transport – use of fuels, air emissions Composting – energy, water, possibly odour	Avoided impacts of fertilizer and pesticide manufacture - materials, energy, emissions, wastes; water conservation and increased crop yield from use of compost as mulch; carbon sequestered in land	Need to change waste disposal patterns, i.e. source separation	New business opportunities in composting
Energy Recovery	Transport – use of fuels, air emissions Energy recovery process – energy, water, emissions, solid wastes (ash, grit, slag, scrubber residue)	Avoided impacts of energy production from other fuel sources – air emissions, waste water, solid wastes (ash) Avoided landfill impacts – air emissions, leachate, visual impact	Possible community opposition to new facilities – perception of environmental impacts Does not encourage re-thinking of consumption habits	New business opportunities in energy recovery
Treatment / stabilisation	Transport – use of fuels, air emissions Treatment process –materials, energy, wastes, possibly odour	Avoided landfill impacts – air emissions, leachate, visual impact; potential energy credit if anaerobic digestion is used (biogas collection and energy generation)	Possible community opposition to new facilities – perception of environmental impacts Does not encourage re-thinking of consumption habits	New business opportunities in waste treatment
Disposal – landfill	Transport – use of fuels, air emissions Landfill impacts – air emissions, leachate, visual impact	Avoided impacts of energy production from other fuel sources – air emissions, waste water, solid wastes (ash) due to gas recovery and energy generation; carbon sequestration	Community opposition to new landfills – visual / aesthetic impact	Low cost of disposal a disincentive to recovery and recycling