Government of South Australia

positionpaper

Zero Waste SA

alternativewaste technologies

Alternative Waste Technologies

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Zero Waste SA
GPO Box 1047
Adelaide SA 5001
Email: zerowaste@state.sa.gov.au
Internet: www.zerowaste.sa.gov.au

Executive summary

South Australia's Waste Strategy 2005-2010 recognises that South Australia will require a diverse and flexible range of policies, technologies and actions to deliver on waste reduction targets. The waste management industry in general faces important long-term decisions about managing the waste stream over future years. New and conventional technologies offer a range of potentially viable options for improving the way we manage waste in South Australia.

Zero Waste SA needs to consider its role in relation to alternative waste technologies (AWTs) and this paper aims to provide the background to Zero Waste SA's decision making.

The paper explores the range of drivers and barriers to commissioning AWTs and identifies cost and the relatively unknown nature of 'new technologies' as the main barriers. The main drivers appear to be increasing cost of landfill and environmental awareness of community. Awareness ultimately impacts on environmental policy and local government's willingness to be seen to be leading edge.

The brief overview of the range of technology options notes that most are not 'new technologies' but rather infrastructure options with a range of benefits and shortfalls for processing a variety of waste streams. The paper also compares the technologies against the waste hierarchy and identifies the focus of most AWTs as being on recovery, which is close to the bottom of the waste hierarchy.

The paper recommends that the Board of Zero Waste SA provide support (funding or advocacy) only for technology and infrastructure options that tackle waste streams without a higher value (both economic and resource value) end use.

South Australia already has relatively well established infrastructure for kerbside recyclables (MRFs), green organics (open windrow composting) and construction and demolition waste (crushers for aggregates and more recently Alternative Fuel Company's energy from residual construction and demolition waste). Given that, it is recommended that support be limited to AWTs tackling waste streams not being captured in currently available infrastructure networks, for example residual municipal waste, and commercial and industrial waste.

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Abbreviations

AWT	alternative waste technology
EU	European Union
MBT	mechanical biological treatment
MRF	material recovery facility
PM0.1, PM1, PM2.5, PM10	particulate matter of less than 0.1, 1, 2.5 and 10 micrometres (respectively) in diameter
RDF	refuse derived fuel
REDI	Renewable Energy Development Initiative
UR-3R	Urban Resource – Reduction, Recovery and Recycling
USEPA	United States Environment Protection Agency
ZWSA	Zero Waste SA

Introduction

South Australia's Waste Strategy 2005-2010 recognises that South Australia will require a diverse and flexible range of policies and actions to deliver on waste reduction targets. The waste management industry in general faces important long-term decisions about managing the waste stream in the future. New and conventional technologies offer a range of potentially viable options for improving the way we manage waste in South Australia.

To date, alternative waste technologies (AWTs) operational in Australia have generally been limited to extraction of biogas from landfills, materials sorting and open windrow composting. Other technologies and infrastructure options are now presenting themselves as alternatives to current solid waste treatments.

The NSW State-owned WSN Environmental Solutions, together with Global Renewables, recently commissioned a UR-3R (Urban Resource – Reduction, Recovery and Recycling) facility at Eastern Creek in the outskirts of Sydney; Western Regional Waste Management Group (Melbourne) has been in negotiations with AWT vendors and the Victorian State Government; and Mindarie Regional Council is in the process of tendering for an AWT to service about 25% of Perth's metropolitan kerbside residual waste. To date, however, very few plants have been effectively using AWT technologies in Australia.

Scope

This paper covers all solid waste except hazardous wastes. It is not designed to provide the solutions to all questions about AWTs. The range of technology and infrastructure options is large and, as the Australian Business Council for Sustainable Energy (2005) and the Waste Management Association of Australia (2004a) both stress, the technology option most suited to each situation depends on many factors.

This paper does not try to answer questions about which technology would be most appropriate for South Australia, but rather aims to identify:

- drivers and barriers for AWTs in overview
- the range of technologies and their application in overview
- national trends in commissioning technologies
- evaluation considerations
- the role of ZWSA
- next steps, options and future priorities.

Drivers and barriers

Drivers for change

In recent years, AWTs have come to the forefront of the consciousness of waste managers around Australia. In reality, many of the ‘new technologies’ have been around for some time. AWTs offer a range of options for the way we manage waste, each with its own benefits, costs, and environmental and social impacts.

The range of drivers for implementing various AWTs includes:

- increasing landfill prices
- higher environmental standards and landfill regulation
- increasing environmental awareness
- proponents and councils keen to be seen as leading edge
- the appeal of a ‘one size fits all’ solution
- potential for reduced collection costs from fewer kerbside collections
- rising recycled commodity prices
- more public–private waste management partnerships
- increasing regionalisation of the management of waste.

The strongest driver for commissioning AWTs is increasing landfill cost. The eastern states of Australia and European countries have commissioned more AWTs primarily for this reason.

In general, landfill rates are rising around the country as landfill space availability decreases and government policy makers respond to the community’s environmental standards. Increasing community awareness of waste issues and political reactions to these changes have led to higher environmental standards for landfills. In Europe, many waste streams, for example putrescible waste, are banned from landfill, providing a further driver for AWTs as councils look more closely at alternative disposal options.

Of less but growing importance are ‘market pull’ factors from sale of products made from recycled material. This is of particular importance for those technologies offering energy as part of the product mix. Many energy producing technologies are ‘carbon neutral’, with no net impact on CO2, in direct contrast to energy production from fossil fuels. Energy from waste projects also avoid the release of methane to the environment further reducing greenhouse gas emissions (Rutovitz and Passey 2004).

Barriers to AWTs

The range of barriers for implementing AWTs includes:

- cost
- unknown nature of ‘new technologies’
- long-term contracts required to make them viable
- community concerns and uncertainty
- financing
- competing methods of managing waste streams
- vulnerable markets for end-products
- concerns over end-product quality
- the need for large volumes of material.

The highest barrier for commissioning AWTs is cost (Nolan ITU 2004). Many of the more complex technology options cost in excess of $100 million, and thus require proponents to secure long contracts with comparatively high gate fees.

The largely unproven nature of these technologies presents one of the greatest risks and many decision makers remain unconvinced that the solutions proposed are significant enough to warrant taking on the extra risk. These waste management systems come at a higher cost to industry, local government and the community. Long-term financial commitments are generally needed to cover the capital and operating costs.

Many of the challenges of resource recovery are complex. Some of the technologies claim to offer simplified ‘one size fits all’ solutions, which are very tempting to decision makers wanting quick solutions to deliver on waste reduction targets. One of the primary barriers for decision makers is being able to effectively challenge and evaluate AWTs in their ability to deliver sustainably on proponent’s claims.

By the very nature of the waste streams, feedstocks are scattered, costly to collect and transport, and often not homogenous. As such, guaranteeing quality and quantity of both supply and end product is often a significant risk factor. For technologies generating electricity, connecting small generators to the electricity grid may require upgrades of the existing electricity network, significantly adding to the cost of new projects.

Other barriers include community concerns and environmental regulation. Communities are typically concerned about the environmental performance of technologies, particularly thermal treatments and their emissions. Regulation is also often complex, with a number of different government authorities responsible for development approval and regulation.

Decision makers

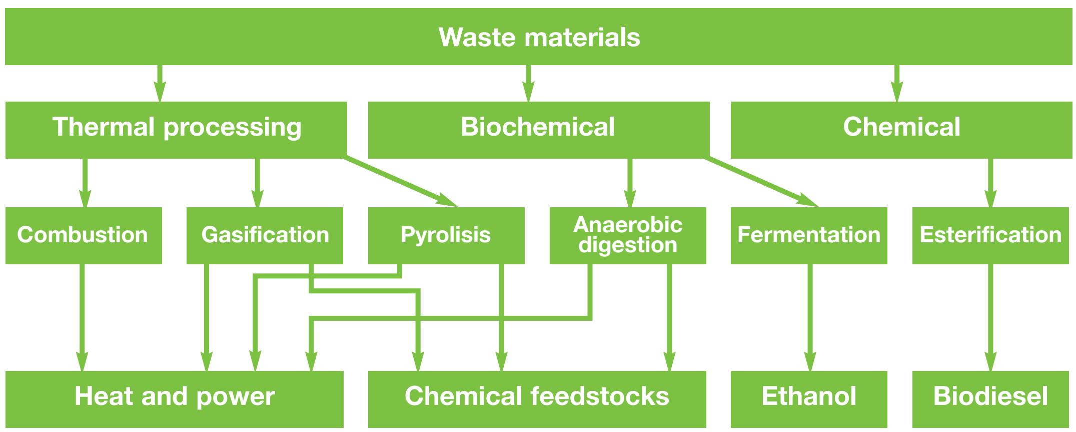
In most cases in Australia, AWTs are commissioned by the private sector but are reliant on supply contracts from local government, industry and waste transport companies. Increasingly, technologies are being commissioned by public–private partnerships and by regional waste management groups.

Other stakeholders include:

- community, including neighbouring residents, businesses, and sensitive land uses such as schools and aged care facilities
- special interest groups and environmental non-government organisations
- local governments and the Local Government Association
- State Government including Environment Protection Authority, Planning SA, Department for Trade and Economic Development, Department for Primary Industries and Resources South Australia
- Australian Government
- waste generators, suppliers and collectors
- project developers and proponents, technology developers and vendors
- energy wholesalers and retailers
- finance providers.

Overview of technologies

This section gives an overview of the main technology and infrastructure options. It is not intended to be a comprehensive guide.



- Steam turbines
- Steam engines
- Stirling engines
- Gas turbines
- Internal combustion engines
- Fuel cells
- Micro-turbines

Figure 1. Overview of process flow for energy from waste technologies
Source: Australian Business Council for Sustainable Energy (2005)

Landfill technologies

The most widespread of all the technologies is methane capture and use from landfills. A proportion of the methane released as disposed waste breaks down under anaerobic conditions in large landfills is captured and then used for energy production. Methane is usually extracted by sinking pipes or wells into the landfill and sucking the gas out. After closure a landfill will continue to produce methane for approximately 15–20 years.

Some emerging new forms of the technology enable methane capture from smaller landfills. Methane production is dependent on anaerobic conditions, and thus the modifications include covering landfills with a membrane that help make the landfill more airtight.

These technologies are the least efficient of the energy from waste technologies: gas capture is incomplete and greenhouse gases (methane) are emitted (Waste Management Association of Australia 2004a).

Waste separation and mechanical sorting

Waste separation can lead to higher value end-use applications. The relative importance of these types of technology depends on the collection system and the extent to which the waste stream is prevented from mixing at source.

The technologies use a variety of physical processes, such as rotating drums and pulverisers, to separate mixed residual wastes. They aim to recover specific waste streams for further processing or reprocessing, or reduced-volume disposal.

An example of the technology was the Brightstar Environmental Autoclave at its Whytes Gully facility in Wollongong (now decommissioned). In the 'autoclave' waste is heated with steam and rotated in batches then separated through screening and sorting. Waste is fed through various tunnel systems into a rotating drum for 1–3 days, with heat being generated through friction and biological action.

Material typically recovered from waste separation technologies is shown in Table 1.

Table 1. Typical recovery from waste separation technologies

Product	% of output	Use
Organic rich fraction	40–50%	feedstock for further biological treatment or converted to energy (not composted due to contamination)
High calorific material	20–30%	primarily plastic, can be recycled or used as refuse derived fuel (RDF)
Inert material	10%	landfilled (bricks, stones, glass)
Ferrous scrap	5%	recycled

Material recovery facilities (MRFs) use automated and manual sorting to separate mixed recyclable materials into groups of specific materials such as brown glass. The outputs are suitable for reuse, recycling or reprocessing. Once these materials have been sorted into specific streams, such as metals, glass and plastics, they can be recycled

MRFs have become a popular recovery alternative for waste management in Australia.

Biological treatments

Several biological treatments, using decomposition by microbial activity, are suitable for organic material sourced from municipal, commercial and industrial sources.

Aerobic composting

Open windrow composting

The simplest of the composting technologies, open windrow composting, uses decomposition of organic materials by microbial activity under open, aerobic conditions to produce a stable organic material containing plant nutrients. Complex organic molecules are broken down by micro-organisms in a moist, oxygen rich environment. This process releases the nutrients and energy contained in the waste material. The material can be used as a soil conditioner. Quality of compost is determined by the quality of feedstock (low to zero contamination) and adequate control (by turning) of aeration, moisture content and temperature.

Enclosed composting

Controlled atmosphere and moisture conditions are used in these technologies to improve the rate of organic waste decomposition and to control odour. Drums, boxes, tunnels, silos or vessels are used to turn food, biosolids and garden wastes into good quality compost. The number of aerobic composting plants used for bio-waste has increased in Europe due to the introduction of source separated collections of municipal organic waste and European Union (EU) directives excluding putrescible waste from landfill.

Vermicomposting

Vermicomposting uses worms to consume organic wastes including biosolids, food waste, animal wastes and organics to produce high quality compost suitable for soil conditioning. An example of commercial scale vermicomposting plant is the Vermitech Redlands facility outside Brisbane.

Anaerobic and digestion

Digestion is the bacterial degradation of organic materials in the absence of oxygen. The methane produced is used for energy production and the nutrient rich organic digestate product is suitable for soil conditioning. The process is carried out in digester tanks or reactors, with temperature and pH controlled for optimum processing. It usually includes mechanical processing, one or two distinct anaerobic decomposition phases, and an aerobic or other stabilising process. The main types are mechanical biological treatment (MBT) and fermentation.

Mechanical biological treatment

MBT typically splits the residual waste stream into 3 fractions: a recyclable stream (glass, metals), a biological stream (for composting of anaerobic digestion) and a fuel stream for energy recovery. About 50 MBT facilities operate in Europe mainly in Germany and Austria, and the rest of Europe has shown considerable interest in these technologies as a means of meeting EU legislative directives prohibiting the disposal of some wastes to landfill including putrescible waste.

The composting procedure significantly reduces biologically decomposable substances. The product is low in gas formation potential, has a low carrying potential of pollutants and subsequent methane generation is reduced. The UR-3R facility at Eastern Creek, Sydney is an example of this type of technology.

Fermentation

In fermentation technologies organic wastes are biologically degraded to produce a chemical feedstock or liquid fuel (usually ethanol).The technology is predominantly used for agricultural wastes, but is also used for municipal organics including food and biosolids.

Thermal technologies

Thermal waste treatment technologies are well established in Europe and North America, with incineration being the most widely used process. Energy is usually recovered in the form of heat and electricity.

Incineration

These mature technologies recover the calorific energy contained in residual waste streams. Conventional ‘mass burn’ incinerators use reciprocating grates to move waste through the combustion chamber, usually at about 200–400 tonnes per day. The stages of combustion are usually: drying and preheating the solid waste, emission and combustion, and burnout and removal. Solid incombustible material is removed as a slag, and is usually landfilled. Flue gas from combustion contains water, combustion gases, oxygen and nitrogen. Air pollution is a critical consideration in incineration because particulates and dust, NOx acid gases and dioxins, furans, polyaromatic hydrocarbons and heavy metals may be generated depending on the process, combustion temperatures and feedstocks.

Cogeneration

Cogeneration harnesses waste heat from electricity production for useful purposes. It captures the heat that comes out of the steam or gas turbine for use in other parts of the process usually in the form of heating. Coopers Brewery is an example of a company using cogeneration to capture 'waste' heat.

New thermal processes

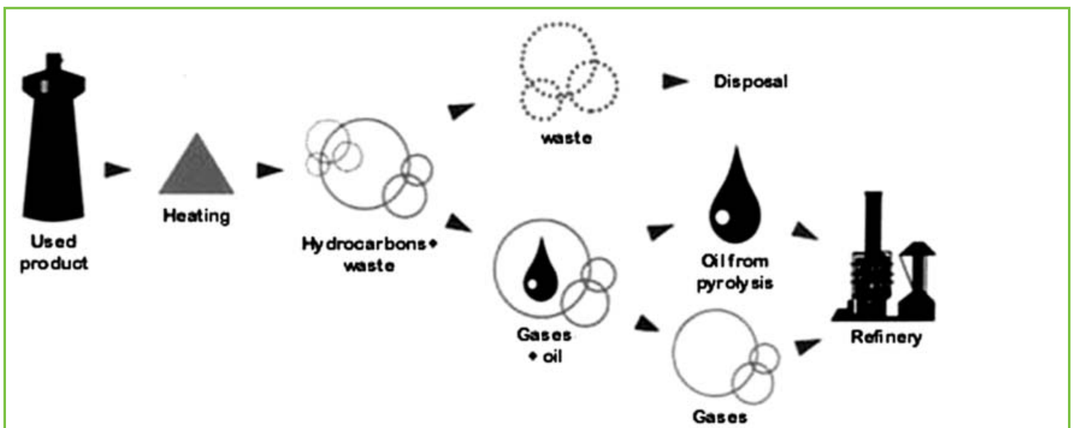
Several new thermal processes including gasification, pyrolysis and combinations of these have recently been adapted to handle municipal solid waste. These technologies require a uniform consistent input stream to ensure reliable operation. For mixed municipal wastes, some form of sorting/separation pre-treatment is required to remove unsuitable materials and ensure consistency.

Pyrolysis

Pyrolysis (Figure 2) involves indirect heating of carbon rich material with the aim of achieving thermal degradation of the material at temperatures of approximately 500°C in the absence of oxygen and under pressure. Useable energy of some 200–400 kilowatt hour per tonne of waste is generated. Energy production and greenhouse gas production are lowered in the absence of oxygen. Heavy metals that are less volatile remain as char, while volatile species need to be captured by gas cleaning systems and treated as hazardous materials. A liquid fraction is produced which may be used, with additional processing, as a synthetic fuel oil.

The number of pyrolysis plants in operation in Australia mainly process reliable and consistent waste streams such as plastics or biosolids. For example, the ESI Enersludge facility in Perth processes sewage sludge into a liquid fuel.

Figure 2. The pyrolysis process

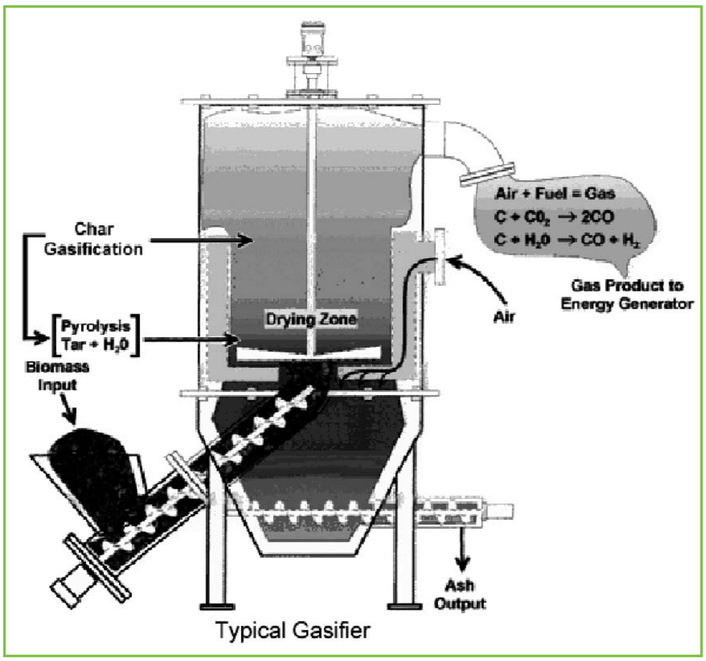


Source: Renewable Energy Systems Test Centre at reslab.com.au/resfiles/waste/text.html

Gasification

Gasification also heats carbon rich material in an atmosphere with slightly reduced oxygen (Figure 3). Most of the carbon is converted to a gaseous form, leaving an inert residue. Relatively high temperatures are used – around 1000°C in air or 1200°C in oxygen. Gasification is considered an energy efficient technique for reducing the volume of solid waste and for recovering energy with a heating value 10–15% that of natural gas (Environmental Engineering Corporation at www.eeco.net).

Figure 3. A typical gasifier



Source: Maunsell Australia (2003)

Waste stream specific technologies

A number of smaller scale technologies present potential options for recovery of specific waste streams. For instance emerging technologies and infrastructure can recover material from used tyres, expanded polystyrene and specific agricultural waste streams.

Wet wastes

'Wet wastes', a general term for waste materials with high moisture content, are generated during intensive livestock production, meat processing, wool scouring, municipal sewage treatment and the production of food, beverages, pulp and paper. The effluents from these industries contain sugars, starches and other organic matter, in a dilute form (Rutovitz and Passey 2004).

Not all of these wastes can be economically used as a feedstock for waste to energy projects. Some operations are not large enough and some waste, such as that from dairy farms, is not practical to collect. Most beef feedlots are open so the effluent stream is intermittent and only occurs when it rains; fruit, vegetable and winery wastes are seasonal.

Among the most promising of the wet waste streams are piggery waste and poultry waste, both growing industries in South Australia. For example a 40 kg pig has the potential to produce waste that generates 28 m3 of methane per year (Sustainable Energy Development Authority 1999). In addition, brewery waste, paper mills and sewage treatment plants may offer some potential. Either cogeneration or anaerobic digestion could be potential approaches.

National trends

Renewable energy certificates, mandatory renewable energy targets* and the national voluntary Green Power Scheme are drivers for technologies that generate energy. A total of $22 million will be spent in 2005–06 on the Renewable Energy Development Initiative (REDI), which provides grants of up to $5 million for projects to commercially develop renewable energy technologies with significant abatement potential (Environmental Manager 2005).

Technologies operating in Australia are summarised in Tables 2 and 3.

New South Wales

New South Wales currently has the highest landfill rates in the country and not surprisingly has more new technologies than other states in Australia. To date most of the more complex technologies have offered at best mixed results.

One of the most recent has been the UR-3R waste management facility at Eastern Creek commissioned in September 2004. The facility currently processes around 175,000 tonnes a year of its capacity of 260,000 tonnes and aims to divert around 80% of waste from landfill. At this early stage, however, the facility is experiencing difficulties and is not delivering on all of its objectives.

Victoria

In Victoria landfill costs are significantly cheaper than New South Wales with recent trends in awarded local government contracts allowing for around $45–50 per tonne of waste to landfill.

Western Regional Waste Management Group and the Greater Metropolitan Regional Waste Management Group have been in negotiations with Global Renewables and the Victorian State Government to commission a UR-3R facility or similar to the west of Melbourne.

AWTs are proving to be a driver for regionalisation of waste management and planning, potentially leading to the formation of one body for the entire metropolitan area that could:

- broker deals with local government and secure supply contracts
- take an effective approach to due diligence and risk management
- investigate public–private partnerships to get facilities up and running.

* The importance of mandatory renewable energy targets is diminishing as the existing program is reaching capacity; the Australian Government has indicated that it will not extend the scheme (in a presentation at 2005 Bioenergy Conference, Adelaide South Australia)

Western Australia

Mindarie Regional Council (40 km north of Perth) is currently tendering for a 20 year deal for the processing of 100,000 tonnes per annum of municipal waste (Inside Waste 2005).

South Australian factors

South Australia's Environment Minister has announced that South Australia has a goal of no new landfills. South Australia's Strategic Plan also has a target to reduce waste to landfill by 25% within 10 years.

In addition, any proposal for commissioning an AWT in South Australia would need to fit in with the priorities outlined in South Australia's Waste Strategy and with existing infrastructure systems. For instance South Australia now has source separation waste collection services from kerbside among the best in the country with demonstrated public willingness and involvement in kerbside recycling. It is recommended that ZWSA, on balance, would therefore not favour AWTs that are reliant on a single bin collection of municipal waste, vegetation waste and recyclables. Where the materials can be presented in defined or homogenous streams, their ability to be reused or recycled is much enhanced (Waste Management Association of Australia 2004a).

Alternative Fuel Company, a joint venture between Resourceco and Adelaide Brighton Cement has recently begun shredding the residual component of construction and demolition waste recycling process and using the shredded material as an alternative fuel source for a cement kiln (Figure 4).

Figure 4. At the Alternative Fuel Company material is fed into a shredder as pretreatment before being used in Adelaide Brighton Cement's cement kiln at Birkenhead as an alternative fuel.

Table 2. Summary of some technologies operating in Australia
Adapted from Australian Business Council for Sustainable Energy (2005) and Waste Management Association of Australia (2004a)

Project	Location	Technology type	Fuel	Commi-ssioned	Status	Energy produced	Capital cost	Developer
Visy Pulp & Paper Mill	Tumut, NSW	Pyrolysis	Black liquor (paper industry)	2001	Operating	20 MW		Visy
Visy Paper	Gibson Island, Brisbane, QLD	Pyrolysis	Black liquor (paper industry)	1997	Operating	2 MW		Visy
Paperlinx	Maryvale Vic	Pyrolysis	Black liquor (paper industry)	1976-89	Operating	54.5 MW		
ESI	Subiaco, WA	Pyrolysis	Biosolids					ESI
Earth Power	Camellia, Parramatta NSW	Anaerobic digestion	Food & agri-cultural waste	2005	Operating	3.5 MW		
Stapylton Green	Stapylton Green, Qld	Fluidised bed combustion (gasification)	Wood waste	2004		5 MW	$12 M	Green Pacific Energy
Brightstar	Wollongong, NSW	Mechanical & gasification	MSW		Decommi-ssioned		Brightstar Environmental	
Bedminster	Port Macquarie, NSW	Aerobic MBT	MSW & biosolids					
Bedminster	Canning Vale, WA	Aerobic MBT						
Kwinana	Kwinana WA	Aerobic MBT	Commercial organics/ biosolids					
Stirling,	Stirling WA	Aerobic MBT	MSW					
Port Stephens	Port Stephens, NSW	Aerobic MBT	MSW & Biosolids					
Carbon Partners	Dandenong, Victoria	Aerobic MBT	Commercial organics					Carbon Partners
Shenton Park	Shenton Park, WA	Aerobic & anaerobic MBT	MSW	2004				
Eastern Creek UR -3R	Eastern Creek, NSW	Aerobic & anaerobic MBT	MSW	2004	Operating	3 MW		Global Renewables
Vermiculture	Lismore, NSW	Vermiculture	Domestic organics					
Blue Circle Southern Cement	Vic	Cement kilns	Tyres, used oil, carbon dust					
Alternative Fuel Company	Wingfield, SA	Cement kilns	Construction & demolition waste	2005	Construct-ion			Alternative Fuel Company

Table 3. Landfill gas projects in Australia

Adapted from Australian Business Council for Sustainable Energy (2005) and Waste Management Association of Australia (2004a)

Project	Technology type	Comm-issioned	Status	Energy produced	Capital cost	Developer
South Australia						
Highbury	landfill gas	1995	operating	1 MW		Energy Developments Ltd
Pedler Creek	landfill gas	1996	operating	2.9 MW		EDL
Tea Tree Gully	landfill gas	1995	operating	1 MW		EDL
Wingfield Plant 1	landfill gas	1994	operating	4 MW		EDL
Wingfield Plant 2	landfill gas	1994	operating	2.1 MW		
ACT						
Belconnen	landfill gas	1999	operating	1 MW		EDL
Mugga Lane,	landfill gas	1999	operating	2.1 MW		EDL
New South Wales						
Shoalhaven	landfill gas	2002	operating	1 MW	$2 M	AGL
Eastern Creek, Plant 1	landfill gas	2002	operating	3.8 MW		EDL
Eastern Creek, Plant 2	landfill gas	2004	operating	2 MW		EDL
Jacks Gully	landfill gas	2001	operating	1 MW		EDL
Lucas Heights, plant 1	landfill gas	1994	operating	5.2 MW		EDL
Lucas Heights, plant 2	landfill gas	1998	operating	13 MW		EDL
West Nowra	landfill gas	2002	operating	1 MW		AGL
Woodlawn	landfill gas	2005	Construction	25 MW		Collex
Belrose	landfill gas	1995	operating	2.1 MW		EDL
Queensland						
Ti Tree	landfill gas	2005	Construction	20 MW		Collex
Ipswich	landfill gas	2004	operating	1 MW		LMS
Swanbank	landfill gas	2002	operating	7–10 MW	$4.5 M	LMS
Suntown Plant	landfill gas	2002	operating	1 MW	$3 M	Energy Impact
Browns Plains	landfill gas	1997	operating	1 MW		EDL
Stapylton	landfill gas	2002	operating	1 MW		Energy Impact
Molendinar	landfill gas	2002	operating	0.7 MW		Energy Impact
Reedy Creek	landfill gas	2003	operating	0.55 MW		Energy Impact
Rochedale	landfill gas	2005	Construction	3.3 MW		LMS
Victoria						
Springvale	landfill gas	1995	operating	7.9 MW		EDL
Corio	landfill gas	1992	operating	1.0 MW		EDL
Brooklyn Project	landfill gas	2002	operating	1 MW		EDL
Berwick	landfill gas	1992	operating	7.2 MW		EDL
Clayton	landfill gas	1995	operating	11 MW		EDL
Broadmeadows	landfill gas	1993	operating	6.9 MW		EDL
Wyndham	landfill gas	2003	operating	1 MW		Energy Impact
Mornington	landfill gas	2002	operating	0.7 MW		Energy Impact
Western Australia						
Kelvin Road	landfill gas	2003	operating	2.1 MW		LMS
Millar Road	landfill gas	2003	operating	1.7 MW		LMS
Tamala Park	landfill gas	2004	operating	1.65 MW		Landfill Gas & Power
Red Hill	landfill gas	1993	operating	2.65 MW		Landfill Gas & Power
Canning Vale	landfill gas	1996	operating	4 MW		Landfill Gas & Power
Kalamunda	landfill gas	1996	operating	1.9 MW		Landfill Gas & Power
Brockway	landfill gas	1994	operating	1 MW		Landfill Gas & Power
Malaga	landfill gas	2005	Construction	1 MW		Landfill Gas & Power
South Cardup	landfill gas	2005	Construction	2.2 MW		Landfill Gas & Power

Evaluation considerations

The evaluation of best resource use goes to the heart of the sustainability debate. If it can be shown that potentially available urban wastes can be directed for higher value reuse, recycling or reprocessing in substantially their current form, then it is apparent that energy from waste is not the best alternative (Waste Management Association of Australia 2004a).

Not one technology type has yet presented all the answers to all the waste challenges. Each varies in performance over a range of factors including feedstock flexibility, technical and performance issues, environmental issues, social acceptance and strength of markets for end products. Effective evaluation needs to take into consideration the trade-offs and benefit–costs in terms of technical, environmental, social and economic outcomes.

A wide range of consultancy reports have been commissioned to identify which of the technology options is optimal. Most reports have limited value as they tend to make general comparisons with many assumptions.

Potential AWT projects are likely to be commissioned either by private companies or increasingly commonly through public–private collaborations. It is unlikely that ZWSA will be directly responsible for evaluating technology options in terms of commissioning a commercial venture. ZWSA may however be required in an advisory capacity and potentially in providing seed funding or other assistance.

Core to any evaluation from a ZWSA perspective will be the objectives, goals and targets in South Australia's Waste Strategy and comparison of the project deliverables against the waste hierarchy.

South Australia's Waste Strategy

The five year strategy is focused on five key objectives:

1. **Foster sustainable behaviour** – simply providing information will not influence people to recycle or reuse material or resources in a sustainable way.
2. **Reduce waste** – achieving substantially less waste going to landfill in South Australia means that materials must be redirected towards more beneficial uses.
3. **Implement effective systems** – South Australia needs to establish, maintain and increase the capacity of recycling systems and reprocessing infrastructure in metropolitan and regional areas.
4. **Implement effective policy instruments** – economic, regulatory and other policy measures must be introduced to give the necessary traction in the marketplace to encourage avoidance, reduction, reuse and recycling of waste.
5. **Cooperate successfully** – the goals and targets of this and future strategies will only be reached with the successful cooperation of a range of stakeholders.

Evaluation considerations

Any proposed technology alternative would need to be consistent with these objectives and the strategy as a whole.

Figure 5 indicates that most technologies operate at the lower end of the waste hierarchy (Figure 5a) and that the waste hierarchy is currently the reverse of the optimum inverse pyramid (Figure 5b).

Figure 5a. Waste hierarchy and indicative technology types

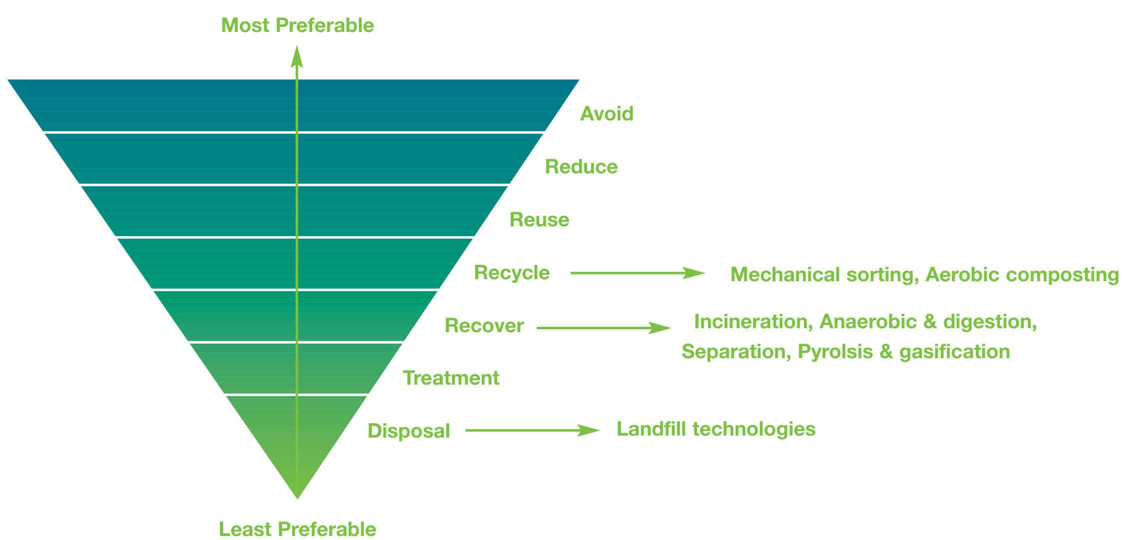
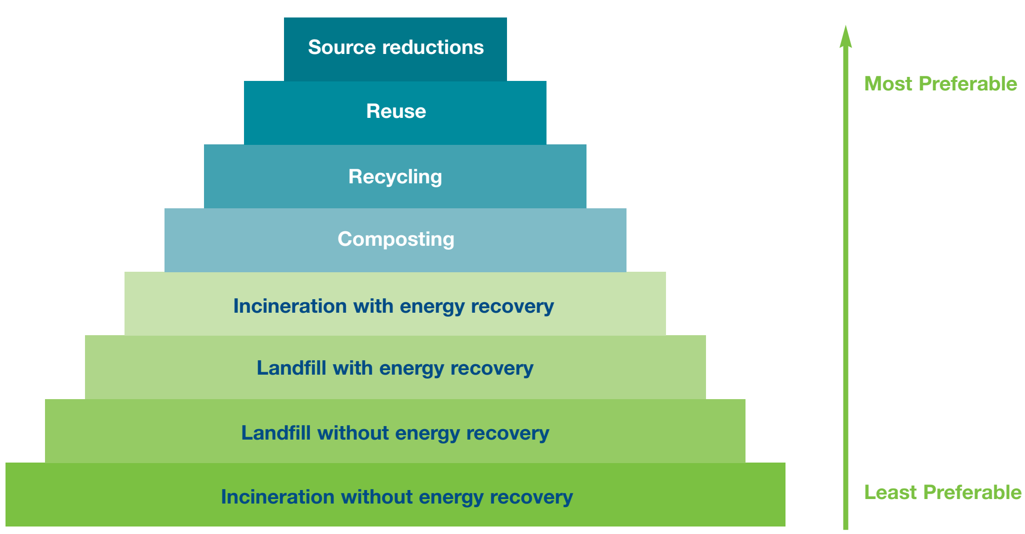


Figure 5b. The hierarchy at present: the reverse of the ZWSA preferred pyramid



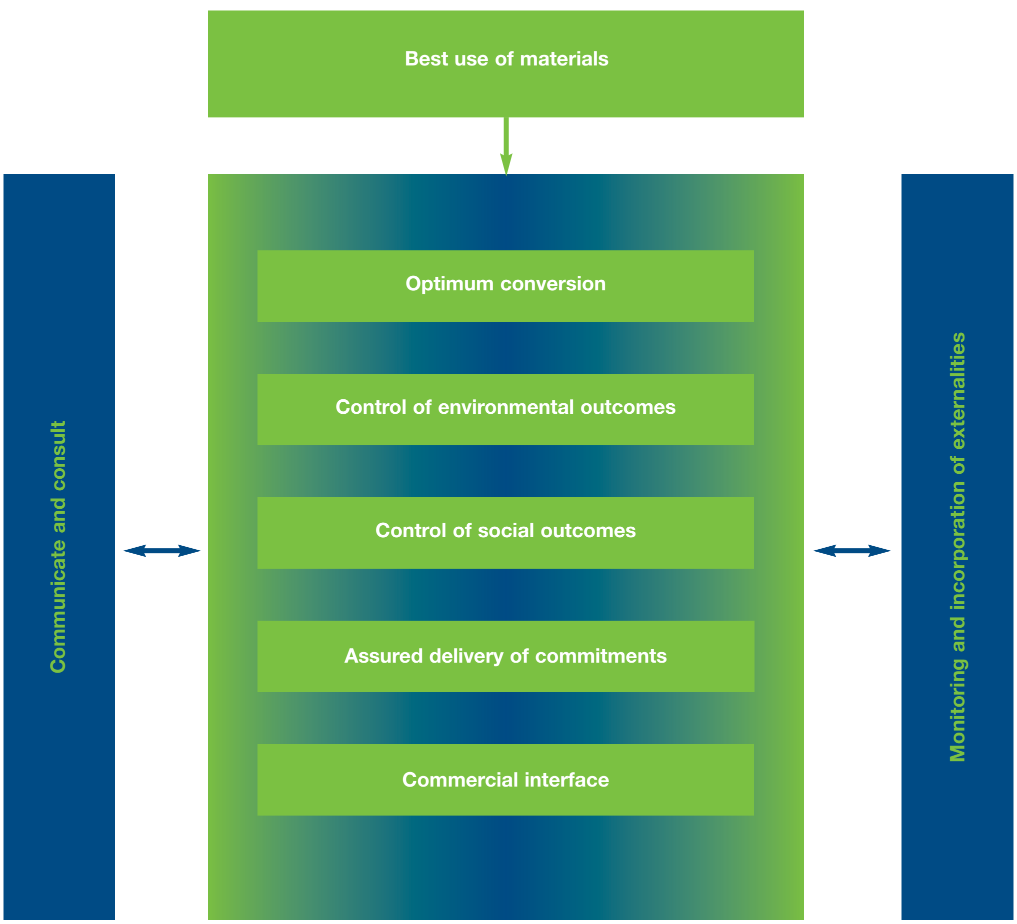
WMAA Sustainability Guide and Code of Practice

Recently, the Waste Management Association of Australia (WMAA) released a sustainability guide for decision making on energy-from-waste projects (Waste Management Association of Australia 2004a). It was designed to help decision makers know when it is best to conserve materials close to their original form, and when it is appropriate to convert them to energy.

The guideline was developed with considerable community and stakeholder consultation and participation. It identified six 'project scoping principles' to be used in assessing energy from waste project proposals (Figure 6).

Figure 6. Assessment roadmap of project scoping principles

Adapted from Waste Management Association of Australia (2004a, page 26)



Evaluation considerations

The assessment process outlined in Figure 6 is a sustainability assessment – and is separate from the commercial feasibility assessment that is the responsibility of the project proponent. The WMAA Energy from Waste Division has also produced a code of practice which commits signatories to recovery of the highest resource value from secondary resource materials and to transparency in decision making, working towards waste avoidance and minimisation, and closing the loop on urban resource consumption (Waste Management Association of Australia (2004b).

Commercial feasibility assessment

A range of factors influence the commercial feasibility assessment and a number of reports and presentations attempt to tackle these assessment concepts. Key to most assessments are:

- cost factors and length of contracts
- product quality and market potential
- technical considerations
- environmental benefits and challenges.

Cost factors and length of contracts

The major cost components of AWTs include:

- development (e.g. planning and design, community consultation, development approval, environmental impact assessment)
- capital
- financing
- feedstock (securing supply; can be income for some feedstocks)
- operational (e.g. maintenance, administration, licensing)
- cost of land, buffer zones.

Product quality and market potential

Available technologies rely for their successful application and financial viability on the products and the markets that they offer benefit to. Compost or organic matter are part of the product mix of many technology options but the quality varies greatly between processes and depends on a range of factors including feedstock quality and the degree of processing/screening.

Energy can be derived from a number of technologies in a variety of forms including steam for electricity generation, pyrolysis oil and syngas, hot water, biogas, refuse derived fuel (RDF). RDF is a high calorific fraction separated from a number of waste streams and can be used to displace fossil fuels in processes such as cement kilns and power stations without significantly increased emissions.

Evaluation considerations

As in Europe and the USA, significant amounts of RDF could be used by industry though it is expected to fetch a low or negative price. In Germany cement kilns are paid in the order of 50 Deutschmarks per tonne to use RDF.

Technical considerations

Technical considerations include operational reliability, flexibility of feedstock, system modularity (adding components to meet demand), process control, staffing requirements, technological maturity, efficiency in waste reduction and the area required (footprint).

Environmental benefits and concerns

Many of the technologies require substantial investment and thus adequate planning. ZWSA would only promote technologies that are in line with the waste hierarchy and that facilitate the highest possible value for the end use of resources recovered from the waste stream. Table 4 summarises some examples of environmental considerations for AWT projects.

Waste is a large contributor to greenhouse emissions through methane production in landfill, transport and processing of waste, and indirectly through lost savings that could be gained though recycling of valuable materials (Grant et al. 2003).

Any AWT may have effects on other aspects of the waste stream and of the waste management system, and may have positive or negative environmental impacts. Technologies need to be evaluated in this context (Grant et al. 2003).

Evaluation considerations

Table 4. Summary of environmental benefits and concerns for AWT projects

Environmental benefits	Environmental concerns
Reduced greenhouse gas emissions by avoiding methane generation, which is a greenhouse gas 21 times more potent than carbon dioxide.	The potential threat to the 'reduce' and 'recycle' elements of the waste hierarchy, in that installing an energy-from-waste capacity may divert valuable recyclables away from environmentally preferable recycling processes and diminish the incentive to reduce waste.
The generation of renewable energy from organic wastes, which offsets the greenhouse and other air emission impacts of electricity generated from brown coal.	The risk of damaging emissions from thermal treatments such as incineration, gasification and pyrolysis.
Improved land care through the application of compost, leading to increased water holding capacity, carbon sequestration and reduced pesticide and fertiliser use.	
A longer life for existing landfills as a result of reduced waste volumes.	

Quantitative studies of waste management options conducted in Europe, America and Australia, have assessed life cycles of waste management options (Grant et al. 2003). In general these studies found improved environmental performance associated with dry material recycling and from source separated aerobic or anaerobic management of organic waste.

Technologies may be applied to ‘source separated’ or ‘residual’ waste streams – for example, anaerobic digestion of food and/or green waste streams collected from a dedicated organic waste bin from households – and generate energy and produce valuable compost material. When applied to residual waste streams (what is left over after taking out the recyclable and garden organic fraction from municipal solid waste), the process is less efficient – both energy output and quality of compost product are lower.

Particulate emissions

Fine particles can be detrimental to health and are very difficult to reduce with the conventional precipitators. Waste incineration produces fine particles that contain toxic elements, such as heavy metals. Decreasing total particle emissions does not necessarily decrease fine particle emissions. There are no plans at the moment to set emission limits for different particle size classes (PM0.1, PM1, PM2.5, PM10) formed in incineration, but it is possible in the future. Not much has been reported about formation of fine particles, emissions from incinerators nor combustion of sorted household waste. In addition, no previous studies could be found on the effect of waste quality (sorted versus unsorted waste) on formation of fine particles and especially on the amount and occurrence of heavy metals. Highly concentrated, high toxicity ash from energy plants may need to be immobilised in cement before landfill.

Technology implementation factors

One of the primary reasons why most AWT projects have failed to meet expectations and deliver on promises is that in most cases they lacked sufficient due diligence and planning in the feasibility and management of projects.

For a $100 million project it would not be unreasonable to assume an allocation of approximately $5 million in feasibility, planning and project management.

In implementing projects of this size, effective project management is critical.

A critical consideration for ZWSA in assessing support for an AWT project through its grant programs, would be project planning that followed modern management techniques which give the project the best chance of success. They are discussed below.

Scope management

Scope management for projects of this size requires scope planning, definition, verification and change control planning. The scope must outline all work required, and only the work required, to complete the project successfully.

Integration management and communication management

Project coordination of various stages of the project, including development of an overarching project plan that incorporates all subplans, is a critical project management step.

Evaluation considerations

Communication and information distribution mechanisms need to be outlined with clear processes to ensure relevant stakeholders are kept well informed. The communication plan should also include a guideline for performance reporting and administrative closure. Communication management must incorporate a plan for community consultation and involvement.

Also critical to success is an appropriate and defined change control process that formally outlines the steps required to vary from the original plan, and lists who is responsible for decision making, who should be notified and how.

Time management

Many AWT facilities in Australia have taken longer to commission than anticipated. Effective time management for projects of this size needs to:

- define and sequence all activities required to deliver project outcomes
- estimate duration of each activity
- develop a schedule and effective control mechanism.

Cost management and resource planning

Proponents must determine the type and quantities of resources, including people, equipment, materials and services, for effectively completing the project within the timeframes identified in the project plan. These resources then need to be accurately costed and budgeted for, again with an identified process for change management when costs deviate from estimates.

Quality management

Quality is best considered from a customer point of view. Stakeholder expectations must be understood at the beginning of the project. If, for instance, the community has the expectations that an energy from waste project is going to have no harmful emissions, project proponents need a thorough understanding of what harmful emissions actually mean to the community.

Quality planning and assurance can help evaluate overall project performance and assure the project will meet the quality standards.

Evaluation considerations

Risk management

Commissioning infrastructure of this proportion entails a high level of risk, and proponents therefore expect a higher rate of return on their investment.

Risk issues of note include:

- long-term feedstock supply contracts and energy supply contracts
- licensing and planning
- community support
- operational risk
- occupational health and safety
- financial risk (including interest rate risk)
- environmental impact risk
- commercial risk (including competition for feedstock materials and end products).

These risks need to be effectively managed if the project is to be successful.

Post-implementation activities

A successful project also requires post-implementation reviews, improvements and effective operational management.

A South Australian Perspective on AWTs

Potential technology vendors need to cover a range of factors including risk, feedstock supply security and flexibility, and cost.

This paper has deliberately avoided mention of specific costings for the infrastructure alternatives as market conditions, policy changes and international commodity prices all conspire to quickly outdate current price estimations. However, a rough indication of the costs of delivering some of the technology options is warranted. The 2003 Environment Protection Authority commissioned study, Alternatives to Landfill – Cost Structures and Related Issues (Maunsell Australia 2003) noted costs ranged from $15 per tonne to $250 per tonne with most options around the $80–$100 per tonne mark. Ultimately the question to be answered is: What is the South Australian community prepared to pay to have their waste treated by one of these technology options?

Also of concern to those interested in commissioning an AWT in South Australia will be material supply security and flexibility. Many technology options rely on large volume throughputs and economies of scale. Although vendors may claim to have solutions that are modular or scaleable depending on available waste streams, in reality most require large volumes of throughput to make a profit and justify the extra risk associated with the required investment.

The current fairly strong competition in South Australia for tonnes of waste is due to the relatively large number of landfills and resource recovery options. For example landfill disposal costs in metropolitan Adelaide are currently around $40 per tonne (including the waste levy). Thus any potential infrastructure alternative would need to be able ensure supply security and price elasticity should markets for required feedstocks and end products fluctuate.

It is also worth reiterating at this point that most technologies operate at the bottom of the waste hierarchy and over time the policies and programs of ZWSA will limit the amount of material available for recovery technologies. Companies that have invested significant funds into infrastructure are not likely to be willing to abandon their investment as the waste/resource emphasis moves higher up the hierarchy.

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