WALGA

Alternative Waste Treatment (AWT) Technology Discussion Paper

PREPARED BY THE

MUNICIPAL WASTE ADVISORY COUNCIL
"Getting the Environment Right"

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Status of this Discussion Paper

This Discussion Paper has been prepared through the Municipal Waste Advisory Council (MWAC) for the Western Australian Local Government Association (WALGA). The Municipal Waste Advisory Council is a standing committee of the WA Local Government Association, with delegated authority to represent the Association in all matters relating to solid waste management. MWAC's membership includes the major Regional Councils (waste management). The Regional Councils members of MWAC include the Eastern Metropolitan Regional Council, Mindarie Regional Council, Rivers Regional Council, Southern Metropolitan Regional Council, Western Metropolitan Regional Council and the City of Geraldton-Greenough. This makes MWAC a unique forum through which all the major Local Government waste management organisations cooperate. This Discussion paper therefore represents the consolidated view of Western Australia Local Government. However, individual Local Governments and Regional Councils may have views that differ from the positions taken here.

As Alternative Waste Treatment is an evolving area, this Discussion Paper will be reviewed every 2 years to ensure ongoing accuracy and relevance.

This Discussion Paper was endorsed by the Municipal Waste Advisory Council at its meeting on Wednesday 17 June 2009.

The Municipal Waste Advisory Council's member organisations are:

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PART ONE – Alternative Waste Treatment Technologies

Introduction

In considering Alternative Waste Treatment (AWT) Technologies it is important to understand some of the drivers for AWT. In 1997, the State Planning Commission in Western Australia released the State Planning Strategy. This document made reference to no more ‘unlined’ landfills to be developed on the Swan Coastal Plain. This acted as a driver for the development of AWT in Western Australia as Regional Councils sought alternatives to landfills. More recently, climate change and global warming considerations are further encouraging AWT technologies.

Many Regional Councils in WA have installed AWT technology for municipal solid waste (MSW), however, with more regions investigating options, it has become apparent that there is a need for a state wide approach and a clear understanding of the various technologes. To ensure informed decisions are made regarding AWT, it is imperative that Regional Councils and Local Governments have resources to assist. Decisions made on AWT today will have long term impacts and hence there is a need for a collaborative approach from industry, Local Government and State Government to relating to decisions and plans for AWT.

The WALGA Background Paper: Policy Statement on Standards For Recycled Organics Applied to Land, December 2007 highlights the 2004 State Government Sustainability Strategy, which set a strategic direction for the staged reduction of waste being disposed to landfill and the Towards Zero Waste 2020 vision. The Background Paper clearly outlines one of the principle issues that must be resolved if the State’s Toward Zero Waste Vision is to be achieved, is the diversion of organics from landfill. The Background Paper further identifies that AWT can assist the waste sector achieve socially, commercially and environmentally sustainable options and ultimately reduce greenhouse gas emissions. This discussion paper aims to identify AWT options, highlighting their benefits and constraints from an environmental, economic and social perspective. It will then introduce AWT in Western Australia currently and into the future.

What is Alternative Waste Treatment Technology?

As the world’s population continues to rise, municipal waste grows from being an environmental problem for Local Government to an issue of national and global importance. Australia is one of the highest produces of domestic and commercial waste in the world, with over 14 million tonnes produced per year. This equates to an average of 1 tonne per person per year (Research Institute for Sustainable Energy, 2008). Growing concern over the management of landfill sites, coupled with the pressure on land availability has seen the development of technologies that convert waste into energy, or useful by-products. This technology is termed alternative waste treatment technology (AWT), designed to recover more resources from the waste stream while minimising the impact on the environment.

AWT can be placed into three broad categories, which include:

- Modifications to conventional landfilling;
- Thermal treatment; and
- Biological treatment.

Figure 1 shows the two main AWT for the treatment of MSW and their outputs (excludes modifications to conventional landfilling).

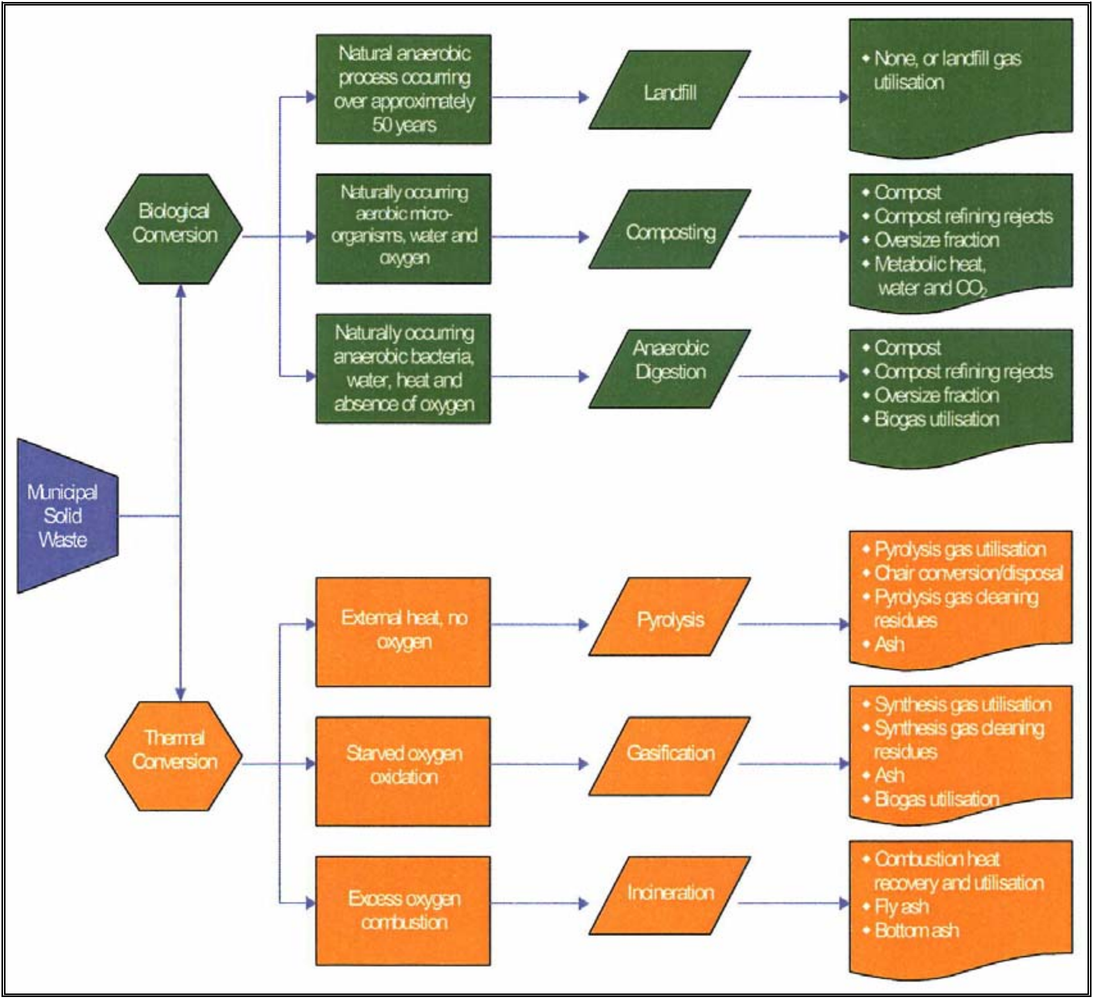

Figure 1: AWT Technologies (Municipal Engineering Foundation Victoria, 2004)

Decisions made by Local Government and Regional Councils on the management of MSW today, will have long term impacts on the community. Decision making bodies must be well informed and act to ensure that the technology selected is effective and considers the environment, social and economic impacts of action. Rather than there be a focus on absolute avoidance of risk to health or the environment, policy makers need to acknowledge the potential impacts of the various technologies and direct resources where they will yield greatest return to society.

It is clear that no single AWT process that presents solutions to all of the waste problems and challenges currently experienced. Local Governments have varying waste management systems in place, environmental, social and economic conditions and hence will have different criteria and parameters to assess when considering AWT. Therefore what is appropriate technology for one area may not be useful in others. The objective for AWT should be to achieve socially, commercially and environmentally sustainable options for managing MSW.

Overview of Technologies

There are many AWT available however only the three main technologies outlined above will be addressed in this document.

Modifications to Conventional Landfill

Modifications to landfills can be categorised into bioreactor landfills and pre-treatment landfills.

Bioreactor Landfills

Bioreactor Landfills are wet landfills which promote the anaerobic degradation of organic components of waste within a reasonable timeframe. Specific management protocols are implemented to increase this degradation, with the most important being the addition of water. This addition of water ensures that the decomposition process is increased through an anaerobic component. Not only can water be added directly to the process but leachate may be recirculated and in some cases sewage sludge added. Other protocols to assist in the process may include waste shredding, pH adjustment, nutrient addition and temperature management.

The flow rate of the liquid through the landfill must be monitored and controlled through hydraulic conductivity. This flow rate must be adjusted according to compaction of the landfill, which changes over time. Settlement varies with rapid initial settlement from compaction, capping and future waste placed above. Waste rearranges and settlement continues until finally biodegradation releases gas for energy and leachate for reuse in the system.

The main challenges with bioreactor landfills are operational. Existing landfill practices results in barriers to water contacting and moving uniformly through the waste. Furthermore infrastructure for the injection and drainage of fluid through the landfill is prone to biochemical fouling. Any excess leachate requires treatment prior to disposal.

The cost associated with bioreactor landfills both in terms of their construction and operational costs are relatively unknown.

Pre-treatment Landfill

Pre-treatment landfills are landfills where the biodegradable or putrescible waste undergoes mechanical and biological pre-treatment to reduce pollution potential of the waste over the lifecycle of the landfill it's placed in. Mechanical processes includes the shredding and sorting of materials with the extraction of ferrous metals.

The shredding of waste is designed to increase surface area of materials so as to enhance biological processes. The screening process separates the high calorific materials such as plastic and paper from organic components. Biological treatment of organic components will be addressed further on in this paper. The product however is disposed of to landfill rather than used as compost or reapplied to land.

The operating costs for a pre-treatment landfill range from $160-$200 per tonne (EPA, 2003).

Biological Conversion

Biological Conversion technologies include

- Aerobic Decomposition
- Anaerobic Digestion

Aerobic Decomposition

Aerobic decomposition involves the decomposition of organic materials by microbial activity under aerobic conditions. The end product is dependant on waste systems and process configurations achieving either waste stabilisation, fuel production or a stable organic compost containing plant nutrients. The quality of material is determined by the quality of feedstock and adequate control in the form of aeration, moisture and temperature.

There are numerous different techniques used in aerobic decomposition which include;

- Green Waste Composting in open windrows – the decomposition of green organics, garden waste and sewage sludge through microbial activity in moist rich aerobic conditions. Piles are turned and watered in order to control moisture content and minimise anaerobic processes from occurring. The process takes 6-12 weeks. Different grades of material require different lengths of composting to ensure weeds or pathogens are destroyed.

- Aerated Static Pile – Green waste and food waste are piled on perforated concrete and covered by mature compost or wood chips with air drawn through the stationary pile. Material is cured for four to six weeks before being screened and processed to produce compost.
- Drum systems – Aerobic drums can process either source separated organics or mixed waste. Drums are generally 40 – 60 meters long and about four and a half meters in diameter. Waste is mixed and homogenised within the rotating drums. Waste is loaded into the drums from the storage/tipping floor and biosolids and water added to obtain the right moisture content. Material is processed in the drums for approximately 3-4 days at temperatures between 55 – 65 degrees Celsius. Materials are then screened, with recyclables removed and large solid waste disposed of. Screened material is then placed into open windrows of aerated static piles for a further 30 – 40 days. Material is then processed into a range of compost products. The cost of operating such as system is eapproximately$70 - $110 per tonne of waste input (EPA, 2003).
- Enclosed Tunnel system – Common in Europe, this system not only produces good quality compost, but can also act as a mechanical and biological pre-treatment of waste for landfill. Enclosed composting controls the atmosphere and moisture, improving organic waste decomposition and odour control. MSW is pre-treated to reduce particle size then mixed with organic and green waste. After steel is removed magnetically, the material is loaded into a primary tunnel, sealed and composted for 14 days. After this primary composting, material is screened and processed to remove metals and unwanted items. Undersize material is placed in a secondary tunnel and further composed for 14 days and oversized material returned to the primary tunnel to repeat the process. Finished compost is processed further to remove any contaminants to produce a saleable product. The estimated cost of this technology is $60 - $90 per tonne of waste, based on 20,000 – 100,000 tonnes of waste per year processing plants (EPA, 2003).
- Aerobic Digestion – The Canadian company, International Bio-Recovery Corporation (IBR) has developed a system where by solid waste is shredded and contaminants removed. Material is made into a slurry which is aerated in digesters. Following this digestion phase, material is cleaned and dewatered, resulting in a solid fertiliser. The solid is then dried, pelleted and used as fertiliser for commercial or private use. The cost of this technology is approximately $50-$70 per tonne with plants in operating in Ireland, Northern Ireland and England (EPA, 2003)

Vermicomposting

Vermicomposting uses worms to consume food waste, biosolids, animal wastes and organic material to produce a high quality soil conditioner. Vermicomposting aims to achieve the following outcomes:

- earthworm biomass for worm farming purposes
- produce vermicast for agricultural and environmental management
- reduce organic waste volumes through vermistabilisation.

There are a variety of instruments, processes and strategies in the management of Vermicomposting systems. Vermicomposting and systems generally vary based on the set up of the unit. The environmental management is generally the same for all systems, however there are slight variations depending on the species of worms used. With this in mind, the general environmental conditions are outlined below;

- Bedding should be 'tossed' to loosen and aerate, however care must be taken not to bury food. This process assists to maximise oxygen penetration and keep the system in an aerobic state.
- Temperature is one of the most important factors in Vermicomposting. Optimum temperatures for bedding mass varies from 20^{o}C-30^{o}C depending on the species of worms employed.
- Moisture is an important consideration, with too much moisture pushing the system into an anaerobic state, and too little resulting in dehydration of the worms. 80% moisture is considered ideal
- pH of a system decreases and waste decomposes. The ideal pH range is between 4.5 – 9
- Particle size of feedstock should be varied so as to maintain optimum aerobic conditions. The smaller the particles the greater the surface area and the easier it is for the worms to ingest and breakdown. If the particle s are too small however, there is a risk of compaction and hence the system will move into an anaerobic state.
- Pre-treatment of feedstock may be necessary in some cases such as with problematic waste streams. Pre-treatment could take the form of primary decomposition or pre-composting to reduce feedstock toxicity.

Vermicomposting as a form of waste management is still a relatively new technology. Differing feedstock, the species of worms as well as the management practices adopted, results in varying quality and performance of Vermicomposting products on the market. The majority of vermiculture operations currently adopted are midscale on site units manufactured and adopted to the domestic market. There are mid and large scale units treating commercial and industrial waste streams, however there is little available data on the process rates of different waste streams that these are capable of.

Anaerobic Digestion

Bacterial decomposition of organic matter occurs in the absence of oxygen to produce methane and organic compost. Methane is used for energy production and the compost used for soil conditioning. This process is carried out in a controlled environment with pH and temperature monitored. This is usually a three stage process, including mechanical processing, one or two anaerobic decomposition phases and aerobic stabilising process. There are two main types of biological treatment, 'mechanical biological treatment' and 'fermentation'.

Mechanical treatment is well established in Europe, used for the treatment of source separated solid organic waste. Pre-treatment is necessary to remove non-organic materials which may inhibit the anaerobic process and/or produce unwanted metals or elements that may be harmful. Following pre-treatment, material is placed into reactor vessel (digester) where anaerobic microbial digestion takes place, in controlled environmental conditions including moisture, pH and temperature. The digestion process takes approximately 5 – 20 days after which material may be pumped from the digester to a storage tank where biogas continues to be processed. An aerobic phase may follow to ensure all pathogens are destroyed.

By-products of the process include biogas in the form of methane and carbon dioxide as well as digestate sludge. The biogas can be captured for energy production and the sludge used as a landfill cover or for agricultural purposes. It may also be further refined to produce a soil conditioner or compost. The cost of this technology is estimated to be in the range of $80 - $150 tonne of waste input (EPA, 2003).

Fermentation is an extension of the mechanical process outline above. Biogas is produced and used to manufacture industrial feedstock such as ethanol. Fermentation technology mainly uses agricultural waste as the raw material, however, interest is mounting for using MSW.

Thermal Technologies

Thermal technologies are processes that use heat to decompose waste to produce stable residue for disposal. MSW has a calorific value of approximately 11 mega joules (MJ) per tonne (Maunsell, 2003). The three thermal technologies assessed in this paper are:

- Incineration;
- Pyrolysis; and
- Gasification.

Incineration

Incinerating MSW reduces the volume of the waste by approximately 95% of its original, whilst sterilising the hazardous components. The two types of incineration addressed in this paper are mass burn incineration and fluidised bed incineration.

- Mass Burn Incineration - This is the conventional system of incineration consisting of the combustion of a variety of waste types through mass burn. It is a common technology used in Europe and Japan for the treatment and disposal of MSW. There is little to no preparation involved and it consists of three stages; the drying and preheating of solid waste, ignition and combustion and the removal of ash and burnout. Waste is fed into the incinerator via a charging chute. It is dried and ignited whilst on the first grate, and when it reaches the second grate it's burnt out, leaving the furnace in the form of clinker.

  The organic component of the material is oxidised into carbon dioxide and water and the remaining incombustible waste is removed as ash or slag. Magnets are used to recover any ferrous material from the ash or slag and the remaining material is generally landfilled. Gases from the combustion process contain water, particulates and dust, oxides of nitrogen, acid gases and dioxins, furans, polyaromatic hydrocarbons and heavy metals (Maunsell, 2003).

- Mass burn is a relatively inefficient means of energy production, with MSW typically having 8 to 12 MJ/kg compared to 22MJ/kg for coal. It does however eliminate large amounts of MSW (Municipal Engineering Foundation Victoria, 2004). A typical mass burn incinerator is shown in Figure 2.

- Fluidised Bed Combustion – Waste is pre – treated for this incineration process to reduce particle size increasing calorific value prior to combustion. Pre-treated material is placed on a fixed bed within the combustion chamber. The bed consists of sand, or another fine solid, and is transformed into a liquid state through contact with an upward flowing gas. The result is a greater burnout of carbon compared to mass burn combustion.

Scandinavia and Canada use this technology for the incineration of fuel such as coal, bark and woodchips, however, it is not get a proven technology for MSW. The advantage this process has over mass burn however, is the reduced concentration of furans and dioxins in emissions, hence a reduction on the cost of gas emission cleanup. There is however the potential for erosion of the vessel due to the production of fine particles.

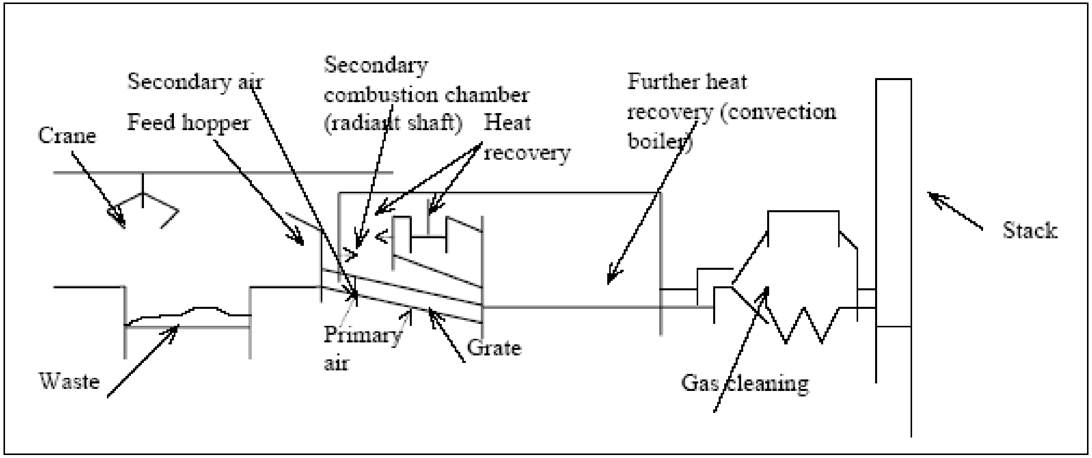

Figure 2: Typical Mass Burner Incinerator (Municipal Engineering Foundation Victoria, 2004)

Additional technology required to control the emissions for incineration adds a significant financial costs to the process and the potential toxicity of emissions a significant social cost. Furthermore the heterogeneous nature of MSW and high moisture content, conventional incineration equipment needs to be specialised for the use with MSW, adding to the cost if incineration for the treatment of MSW. The financial cost of incineration is estimated to be \$170 - \$250 per tonne of waste input (Maunsell, 2003).

Incineration technology is not without its advantages, with the obvious advantage of decreasing the volume of unsorted MSW by up to 95%. Furthermore a sterile residue is produced from a neutral energy process. It is anticipated that the future may see ash produced form the process sold to the construction and road building industries, to be used for construction, which will further reduce the materials going to landfill.

Pyrolysis

Pyrolysis involves the heating of carbon rich material, resulting in thermal degradation, at temperatures between 350°C and 800°C. The process is conducted in the absence of oxygen, resulting in a reduction of energy and greenhouse gasses produced. The process produces a hydrocarbon rich gas mixture leaving an inert residue containing carbon, ash, glass and non-oxidised metals. If the gas is allowed to cool, a hydrocarbon rich liquid will form. This liquid can be used as a synthetic fuel oil with further processing.

Pyrolysis is a relatively costly technology, which requires a back up fuel during the initial set up phase. The waste needs to be shredded before entering the unit and the resulting product requires further treatment to extract the toxins and carcinogenic compounds it contains. Pyrolysis does have many advantages however, including the retention of heavy metals in the char rather than the ash from the combustion process. Although there is a need for fuel to be added to the initial stages of the process, there is a neutral net energy requirement for the process as a whole. The process produces less toxic gasses requiring further treatment and produces less dioxins and furans than the mass burn incineration (Municipal Engineering Foundation Victoria, 2004).

Gasification

The gasification process converts organic material into combustible gases through partial oxidation under extreme heat (around 1000°C). Pre-treatment of waste is necessary to remove contaminants and waste shredded prior to being loaded into a reactor. The majority of carbon is converted into a gas resulting in an inert residue and a combustible gas. The combustible gas consists of carbon monoxide, hydrogen and methane which can be used as a fuel in boilers, internal combustion engines or gas turbines as well as used to produce methanol or hydrogen (Maunsell, 2003).

Gasification, when integrated with electricity production, proves to be economically and environmentally attractive. It produces less toxic gas than all other processes with the inert slag able to be used in the construction industry. The process has the potential to generate 500 – 600 kWh per tonne of waste with a lower cost than mass burn incineration. The cost range for gasification and Pyrolysis is estimated to be between $100 - $170 per tonne (Maunsell, 2003).

Waste for gasification does require pre-treatment through shredding and sorting. The resulting gas does require treatment prior to use in vehicles. A typical Gasifier is shown in Figure 3.

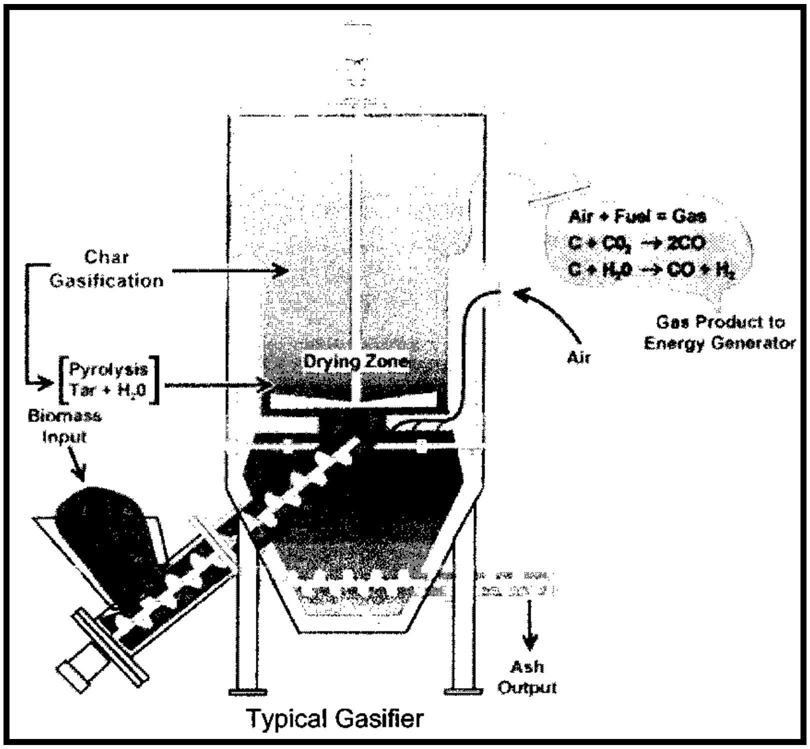

Figure 3: A Typical Gasifier (Maunsell, 2003)

PART TWO – Decision Making

Introduction

Alternative Waste Treatment technologies, as outlined in Part One of the Discussion Paper, are technologies that convert waste into energy or other useful products and provide an alternative to traditional landfilling. Traditional landfilling of waste is becoming the least attractive method of dealing with Municipal Solid Waste (MSW) in WA. Although landfill has its place in the overall management of waste, there are alternative means of utilising waste as a resource and reducing the carbon impact of that material.

For AWT, 'one size does not fit all', no single AWT technology presents solutions to all the waste management issues. Each technology varies in terms of performance, environmental and social impacts and end product markets. Each region of WA has different environmental, social and economic constraints which will effect the waste production and technology selection. Western Australia can learn from the experiences of other states and nations who have implemented AWT; however must find the technologies that best fit the Western Australia context. Ultimately, for the state to work *Toward Zero Waste*, a variety of AWT technologies will be required.

Prior to any decision and investment on a preferred technology, it must be asked whether the AWT is in accordance with the sustainability principle; as defined in the WA State Sustainability Strategy "meeting the needs of current and future generations though simultaneous environmental, social and economic improvement" (WA Department of Premier and Cabinet, 2004). End product markets are also a key concern in technology selection and require strategic policy direction, coordination and vision by all spheres of government. Leaders in the waste industry must come together to provide leadership and assistance in formulating a strategy and a vision for government and industry. In turn, government must implement policy to support this vision.

The Local Government Act 1995, states "In carrying out its functions a local government is to use its best endeavours to meet the needs of current and future generations through an integration of environmental protection, social advancement and economic prosperity". As such, any decisions regarding AWT are made within this framework. This paper explores the environmental, social and economic considerations facing decision makers with regard to AWT.

The Planning Phase

There are a variety of decisions regarding site selection and technology which can have varying combinations, hence can rapidly become complex decision making arena. There are a number of tools to assist with a decision making process. Decisions on appropriate AWT can become more difficult with environmental planning, value judgements and public opinion adding to the complexity of the subject. A structured decision making process will ensure a transparent decision making process which provides a justification in support of decisions made.

A decision making tool appropriate to employ with AWT would be 'multi-criteria analysis', which includes three main components:

- a given set of alternatives;
- a set of criteria for comparing the alternatives; and
- a method for ranking the alternatives based on how well they satisfy the criteria.

Decision making tools do not make the decision, instead they assist those involved in decision making to clearly compare options making choices more transparent. There still exists the need for governments to make difficult decisions that must weigh the contending views and values of various segments of the community. There are many resources and computer packages to assist with decision making using structured tools. For example *"Making Good Decisions: A Guide to using Decision-Aiding Techniques in Waste Facility Siting",* David Annandale and Ross Lantzke Institute for Environmental Science Murdoch University, Perth, Australia, was produced with grant assistance, from the Western Australian Waste Management and Recycling Fund. This document gives step by step guidance on two decision making tools to assist decisions within the waste industry.

As part of the decision making process, a selection criteria should be established and technologies assessed against this criteria. An example of a criteria and factors to consider are outlined below.

Criteria for Evaluating AWT

- Environmental considerations
    - Process Control – degree of difficulty in controlling the process
    - Emissions and odour - to what extent are the processes enclosed
    - Commercial track record – what is the commercial track record of technology and proponent
    - Quality control – what is the risk of non-compliance with regulations
    - What are the environmental benefits and costs? Could small increases in cost decrease environmental impact? Conversely, would it be possible to significantly decrease costs with only small detriment to the environment?
- Social considerations
    - Social Acceptability – community perception of technology
    - Administration Feasibility – is the practice administratively feasible?
    - Risk to public health and safety – Will the technology result in an actual risk to the public?
    - Effects on other sectors – how would other sectors be effected by the technology, and do these effects promote or conflict with overall social goals of the community.
- Economic considerations
    - Feasibility of Technology – is the technology feasible given the financial, and human resources available?
    - Capital costs
    - Operational costs

As the composition and quantity of MSW varies from region to region, influenced by demographics, geographical constraints and socioeconomics, no one AWT technology would be appropriate for all areas. Consideration must be given to the parameters of each technology when making a decision on the most appropriate technology for a particular region. A suggested list of parameters is outlined below.

Parameters for Consideration

Environmental

- Environmental conditions

    - physical – topography, proximity to surface water bodies, depth to groundwater, soil characteristics
    - climate – temperature, propensity of thermal inversions and winds, rainfall
    - specific environmental sensitivities
- Waste characteristics – density, moisture, recyclability, combustibility, hazardous materials

Social

- City Characteristics – population density, infrastructure development, planned development, size of city
- Social and political – degree of and importance assigned to community involvement, political constraints and the nature of these constraints, social and cultural practices
- Existing AWT in the State
- Social risk assessment at the planning phase of the process provides the opportunity to gather public opinion, interests and concerns providing a framework for follow up public consultation which would correspond to every step of the project.

Economic

- Cost of technology (variable factor for each location, Local Government and technology)
- Type of contract entered into to operate AWT

The planning process should incorporate input from public and private entities with and expertise in MSW, management, public health, environmental protection, finance, urban infrastructure and social issues.

Following the sustainability principle, an environmental, social and economic evaluation of AWT will be addressed below.

Environmental Considerations

Environmental considerations need to be addressed throughout the planning phase of any AWT facility, and continue throughout the life of a plant. It is these environmental considerations and impacts which may be a key community concern. The evolution of science and technology has perhaps been more rapid than the education of the community and government policy, with current environmental management practices and controls minimising and in many cases eliminating negative environmental impacts. As a consequence, particular forms of AWT are deemed unacceptable by communities. If WA is to achieve the States vision of *Towards Zero Waste*, it is important that technologies, as long as they meet environmental standards, be considered. Responsibility rests with both State and Local Government, to set standards and implement best practice environmental management.

Environmental concerns follow the life span of a facility, from identifying an appropriate site for a facility to the retirement of a facility. Where the facility has potential to significantly impact the environment, an Environmental Impact Assessment (EIA) will be required. The significance of the environmental impacts will be decided by the Environmental Protection Authority (EPA) based upon the following factors

- the extent and consequences of biophysical impacts;
- the environmental values of the area affected;
- the extent to which emissions (if any) may impact on the health, comfort, welfare, convenience, comfort or amenity of people;
- the potential of the biophysical impacts to significantly and adversely affect the social surroundings of people;
- the extent and rigour to which potential impacts have been investigated and described in the referral, and the confidence in the reliability of the predicted impacts;
- the extent to which the proposal implements the principles of sustainability;
- the ability of “decision-making authorities” to place conditions on the proposals to ensure required environmental outcomes are achieved; and
- the likely degree of public interest and the extent to which interested and affected people have been consulted.

Source: *Factsheet 5. Environmental impact assessment in Western Australia. Environmental Defenders Office WA (Inc).*

The (EPA) then decide on the level of assessment required. There are four types of formal assessment, which are briefly described below.

- Assessment in Referral Information (ARI)

Where the proposal raises one or more significant, but manageable, environmental factors however conditions set by another authority will not be appropriate.

- Environmental Protection Statement (EPS)
  Where the proposal raises a number of significant environmental factors, which can be readily managed. The proponent must submit an EPS document and the EPA reports on the proposal to the Minister outlining conditions which should be applied to the proposal.
- Public Environmental Review (PER)
  Applies to a proposal of local or regional significance which has a number of significant environmental factors. The proponent must submit an Environmental Scoping document, which identifies environmental factors and associated studies, as well as a PER document addressing environmental factors identified in the scoping document. A four to eight week period of public review follows, and the proponent is required to respond to each submission. The EPA reports on the proposal to the Minister.
- Environmental Review and Management Programme (ERMP)
  Where the proposal is of State significance which raises a number of significant environmental issues. The proponent once again is required to submit and Environmental Scoping Document (which may have a public review of two weeks) and an ERMP which has an associated public review of 10 – 12 weeks. The proponent is required to respond to each submission after which the EPA will report to the Minister.

Once a proposal has been approved, the Department of Environment and Conservation (DEC) will then assess the proposal and if acceptable, will issue a Works Approval prior to the construction, and a Licence prior to operations. Currently, any Incinerator which processes 100kg or more per hour of material, or a compost facility which process 1,000 tonnes or more per year require a Licence prior to operations.

As part of an EIA, an ecological evaluation may be required to ensure that there is no potential for the proposed development to impact on protected matter. Such protected matter could include; world heritage property, a national heritage place, internationally important wetlands (RAMSAR Wetlands), nationally listed threatened species and ecological communities and any nationally listed migratory species. Should there be potential for harm or impact, Australian Government approvals will be required under the *Environmental Protection and Biodiversity Conservation Act 1999*.

Social Evaluation

One of the main drivers of any given decision on appropriate AWT is social awareness and acceptance of any proposed technology. Waste management may be a contentious issue, with few members of society welcoming a waste disposal/processing facility, be it landfill or AWT near their homes. It is recommended that within the planning phase of the project, a Social Risk Assessment be of high priority and include the following components:

- identify stakeholders
- develop a program for all stakeholders
- profile social/economic situation of the area
- identify concerns and issues of stakeholders and develop social impact categories i.e. employment, property values, conservation
- Identify probability, magnitude and extent of effects of the project
- create strategies for mitigating potential adverse social effects arising from lack of understanding
- Monitor progress and report to stakeholders

Community consultation (CC) should be included in the initial stages of the project to ensure that an appropriate level of consultation takes place within a suitable timeframe. The underlying principles of community consultation are outlined below:

- Community must be given the opportunity to give input into decisions about matters which may effect their lives
- The CC process should actively seek out and facilitate the involvement of those individuals and groups potentially affected by the decisions
- All participants should have fair and equitable access to the community consultation process
- The planned community consultation process to be communicated to all participants at the outset with participants involved in defining how they participate
- The community should be provided with the information they need to participate
- The CC process to communicate the interests and concerns of all participants
- The community's contribution and concerns must be taken into consideration decisions
- The community consultation process should provide feedback to the participants on how their input was incorporated and how it affected the decision
- All commitments made as part of the CC process should be made in good faith

(Based on the International Association for Public Participation's *Core Values for the Practice of Public Participation* (IAP2, 2000))

Community involvement through community consultation does not secure outcomes that are acceptable to all parties or resolve all differences. It does, however, give the community the opportunity to view concerns within a fair and transparent process. Community consultation represents best practice environmental management, and the EPA gives consideration to the level of community consultation a proponent has undertaken when deciding on the level of assessment required for the proposal. An adequate community consultation process should limit the number of public appeals received on a proposal and allow the Minister to make more informed decisions when deciding on the proposal.

The Department of Environment have produced a comprehensive document, *Interim Industry Guide to Community Involvement, December 2003* which outlines in detail the community consultation process. The document provides tools for effective community involvement from the proposal planning stage and through the life of the development.

Economic Considerations

Decision makers must consider the financial costs associated with both the establishment, operational and maintenance of an AWT. Long term planning is also required to ensure consideration of what will happen at the end of the facilities life. The current activity regarding the Carbon Trading will affect AWT in different ways depending on the Scheme introduced. Until the Scheme is finalised it will be difficult to determine whether all AWT technologies will be able to generate carbon offsets.

Local Governments also need to consider what contractual arrangements suit their particular situation. Types of contractual arrangement include:

- Local Government own and operate;
- Build Own Operate (BOO);
- Build Own Operate Transfer (BOOT);
- Design & Construct (D&C);
- Engineering Procurement Construction Management (EPCM);
- Alliance; and
- Joint Venture (incorporated or unincorporated).

The different contractual arrangements have various advantages and disadvantages and the particular model selected will depend on the requirements of the individual Local Government or Regional Council.

There are substantial costs surrounding AWT in the developmental phase, with planning, design and community consultation. Furthermore, the EIA process and approvals significantly adds to this cost, coupled with the cost of land and buffer zones which will be essential in Ministerial signoff of any EIA process.

When considering the economic parameters of a particular technology, an evaluation of the availability of feedstock throughout the life span of a facility must be acknowledged. This analysis should incorporate current and forecast population densities, to ensure the technology has the capacity to cope with current and increased feedstock during the entire life span of a facility. Further analysis should be made on the markets of end products to ensure there is a commercially viable market for the product. Without a strong end of product market, the AWT will not be economically viable.

Cost considerations differ between technologies, with the construction and operational costs associated with energy from waste technologies greater than that of biological technologies. For example, energy from waste operations may need to consider the costs associated with connection to the grid, whereas biological AWT may require market development for its end product.

Risks Considerations

Each AWT technology has associated risks. It is imperative that these risks be addressed and mitigation strategies be put in place in the planning phase. Risks that should be considered with all AWT include:

- Feedstock and energy supply contracts
- community support
- operational risk
- OH&S
- Financial risk

- EIA
- commercial risk

Thermal vs. Biological – An Environmental Comparison

Environmental Benefits – Thermal AWT

Climate change is perhaps greatest environmental challenge in Australia. Australia is one of the greatest greenhouse gas produces per capita in the world. The generation of electricity is the largest contributor to the growing GHG emissions accounting for 35%. Burning of coal creates the highest GHG emissions in Australia, which attributes to 80% of Australia's power generation. Emissions from waste account for 3% of Australia's GHG emissions (BCSE, 2005).

Waste to energy offers an opportunity to move the production of energy from fossil fuels to waste. It is essential that we move toward more sustainable energy production and waste to energy not only displaces the production of energy from fossil fuels but reduces GHG emissions through avoided landfill emissions.

Environmental Concerns – Thermal AWT

Emissions and ash produced in Thermal AWT is one of the principal environmental concerns. Emissions from thermal processes usually contain a variety of materials; of particular concerns are lead, mercury, cadmium, dioxins and furans, sulphur dioxide and hydrogen chloride, particulate matter such as dust and grit, nitrogen oxides and carbon monoxide. Exposure to emissions can come in the form of inhalation, ingestion and dermal contact with contaminated soil and dust. Research has shown that ingestion and skin contact pose more significant risks than inhalation of emissions. Risks are also associated with ingesting food that has been contaminated with these substances. Effects of exposure to emissions will depend on concentration of contaminants in the emissions and the environmental controls employed, as well as the height of the emissions stack, the geology, the location of the facility and the prevailing winds

The residual ash from the incineration process contains concentrations of heavy metals namely lead, cadmium, mercury, arsenic, copper and zinc. The heavy metals originate from plastics, coloured printing inks, batteries, certain rubber products and hazardous waste. The ash may also contain organic compounds such as dioxins and furans. The principle environmental concern is with the disposal of this ash to landfill. Toxic materials can leach and migrate to groundwater or nearby surface water bodies, increasing the risk of water contamination. There are also health risks associated with the ash through direct inhalation or ingestion of airborne or settled ash.

It should be highlighted that the actual magnitude of these risks, both from emission and ash exposure has been debated. There has been much research over the actual environmental risks posed by the ash and the concentrations of contaminants in emissions after modern pollution controls have been put in place. Research has shown that when good pollution controls are installed equipment can remove up to 99% of the dioxins and furans, 99% of heavy metals, 99%particulate matter and 99% of hydrogen chloride, more than 90% sulphur dioxide and up to 65% nitrogen oxides (UNEP, 2008). Furthermore, field tests performed on leachate from actual ash fills in the USA indicated that metal concentrations at most sites were below US hazardous waste classification and in many cases below US drinking Water guidelines (UNEP, 2008). The feedstock for the facility would also affect the emissions.

Outside of the health risks associated with thermal technology, the disadvantage of implementing thermal techniques is that it may take recyclables away from the other uses, such as recycling processes.

Environmental Benefits – Biological AWT

The organic component of MSW in Western Australia is approximately 70 percent, equating to 490,000 tonnes of waste annually (SMRC, 2006). Biological AWT converts this organic waste into a mineral rich soil enhancer which assists to replenish nutrients into the nutrient, buffer poor soil in Western Australia. Applying recycled organics to land increases the water holding capacity of the soil, assisting in carbon sequestration and reduces the need for fertiliser and pesticide application.

Environmental Concerns – Biological AWT

The quality of compost with all biological technologies is dependant on the technical approach used and the composition of input. Composting MSW poses greater risks than does composting green waste and kitchen waste alone. MSW typically contains higher levels of heavy metals than does kitchen and green waste, hence the potential for more contamination of material.

Like thermal AWT, biological processes can release methane gas if inappropriately maintained, and the decomposition process emits carbon dioxide gas. Furthermore, leachate produced can contain biological oxygen demand (BOD) and phenols, which may exceed acceptable discharge limits. This accidence poses few problems if absorbed into the earth or is passed through a sand filter, however if leachate runs off into water bodies, it will have harmful effects on aquatic species. If the compost process is properly managed, leachate should be captured and all leachate absorbed into soil to avoid discharge.

The use of recycled organics on land was addressed in the WALGA *Policy Statement on Standards for Recycled Organics Applied to Land, December 2007*. This document outlines the support for the use of compost to land, however recognises that there is a need for mandatory standards to be in place. Europe is currently the only region to have standards in place for compost, and the lack of mandatory standards in WA may increase the risk of contamination. With mandatory management, product and application standards, coupled with research on pre-processing and process control mechanisms, biological AWT will pose little environmental concern.

A WA Perspective

Regional Councils in WA have currently not adopted any thermal AWT options, instead biological AWT facilities have been utilised. Thermal AWT has had mixed success overseas, and there is currently a lack of relevant data on thermal technologies for the management of MSW. There are currently three biological AWT facilities in operation in the Perth metropolitan area, with two more in the planning phase. The result of these processes will be a large amount of compost, which in many cases will be blended with other organic product prior to use on land. Waste managers are now in a position where they need secure end product markets to support the increasing volumes of compost produced from the increased number of facilities. Without a State policy focused on outcomes rather than processes and state regulations of end products, these end product markets will not be secure, and there is a risk of simply composting material for landfill. With state support and regulation, confidence in end product markets will increase. Thermal technologies are another potential option in working *Towards Zero Waste*. The government policy and community acceptance of thermal technologies is unclear. There is limited understanding of new thermal technologies and associated environmental management processes and consequently limited community support.

Conclusion

The pressure of finding alternatives to current waste management practices in WA is increasing, with a decrease in land availability, a decrease in the capacity of existing landfills and growing awareness of climate change. Technologies and associated environmental management practices are evolving, and there are a variety of technologies on the market today. Regional Councils have been active in progressing alternatives to traditional landfill, with biological technologies either in operation or are planned for the new future. A variety of AWT technologies are available and offer different ways to manage waste. There is limited community understanding as to the current technologies available, their environmental, economic and social impacts and further public education on these options is necessary.

Decision makers selecting AWT technologies appropriate to their area need to be cognisant of environmental, social and financial impacts. It has been highlighted in this paper that if best practice environmental management is put in place, environmental impacts can be minimised. Through community engagement and consultation social concerns can be addressed. And there are a variety of ways financial liabilities and risks can be managed. Strategic planning and policy development at a state level will assist in identifying appropriate technologies for WA. Through a collaborative strategic approach more sustainable waste management can be achieved that assists the state in working *Towards Zero Waste*.

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