WALGA

# Waste to Energy Discussion Paper for Local Government

## 1. Status of this Paper

This Paper has been prepared by the Municipal Waste Advisory Council (MWAC) for the Western Australian Local Government Association (the Association). MWAC is a standing committee of the 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), and a number of Local Governments. This makes MWAC a unique forum through which all the major Local Government waste management organisations cooperate.

This Paper will be used to inform advocacy and communication on the topic of Waste to Energy.

## 2. Introduction

The following Discussion Paper is intended to provide guidance to Local Government on Waste to Energy technologies. It includes an overview of the available technology options, policy context and issues involving decisions on Waste to Energy. The Paper is not intended to be a detailed comparison of technologies or costs, but rather to assist Local Governments in taking a measured and evidenced-based approach to Waste to Energy technologies for the management of municipal solid waste. Under the *Waste Avoidance and Resource Recovery Act 2007,* Local Government has a defined responsibility for "*Local Government waste.*" This includes wastes generated by households, and Local Government activities. As such, this Paper will not specifically address the treatment of other waste streams by Waste to Energy technologies, although other waste streams are mentioned in some of the examples provided.

There are a number of drivers that have led to the development of this Discussion Paper. Firstly, a number of private sector Waste to Energy companies are currently going through the required approval processes to construct and operate Waste to Energy facilities in Western Australia. In conjunction with this, various Local Governments have identified that these technologies could be used to advance the alternative treatment of waste within their boundaries. Finally, there has been a historical lack of policy guidance from the State Government on this issue. This is particularly concerning given the shortfall in resource recovery infrastructure required to meet the 2015 and 2020 targets of the State Waste Strategy[1].

It should be noted that the Review on Waste to Energy Technologies, commissioned by the WA Environmental Protection Authority (EPA) and Waste Authority, was released in April 2013[2]. The findings of the Review have been used to provide advice the Environment Minister on the topic of Waste to Energy, under section 16(e) of the *Environmental Protection Act 1987.* The advice identifies the role of Waste to Energy facilities, as well as a number of recommendations that will be used to guide the uptake of this technology in Western Australia (refer to Appendix 1).
For Waste to Energy facilities it is important to consider the range of different contractual approaches that can be taken[3]. The type of contractual approach that a Local Government decides to take will influence the considerations a Local Government needs to make. Types of contract include:

- Local Government Own and Operate;

[1] DEC (24 October 2012). Strategic Waste Infrastructure Planning Information Session
[2] EPA and Waste Authority (2013). Environmental and Health Performance of Waste to Energy Technologies
[3] MWAC (2009). Alternative Waste Treatment (AWT) Technology Position Paper

- 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).

## 3. Waste to Energy Technologies

### 3.1 What is Waste to Energy?

The term Waste to Energy, refers to a thermal treatment process in which waste materials are converted to energy. The energy is used to generate products such as heat and electricity. Other thermal technologies allow for the conversion of waste to fuels for use in the transport industry or to replace natural gas.

The broad benefits of Waste to Energy as a waste treatment option include:
- A reduction in the amount of material disposed in landfill;
- A reduction in the amount of emissions released from landfill;
- A robust market for any electricity produced; and
- A small reduction in the reliance on traditional energy sources such as coal.

The community concerns with Waste to Energy technologies include:
- Perceptions that these technologies are poor environmental performers that produce toxic emissions (including dioxins, persistent organic pollutants etc);
- Concerns there are no safe levels for emissions, coupled with distrust of monitoring measures;
- Concerns that the technology will be employed to treat toxic wastes;
- Concerns these technologies undermine recycling efforts;
- The substantial costs involved in building and operating facilities; and
- An unwillingness to have a waste treatment facility located near areas used by the public.

### 3.2 What are the different types of Waste to Energy Technologies?

There are two key technologies that fit within the definition of Waste to Energy; *Combustion* and *Other Thermal Treatments*. The majority of Waste to Energy technologies that use municipal waste as a feedstock, require the waste to undergo a pre-treatment phase. This can include reducing particle size, or removing recyclables and inert materials[4] (refer to Section 4.2.1 for more information). Pre-treatment ensures a more consistent feedstock, and reduces some of the issues associated with 'tarring,' which can cause Waste to Energy facilities to experience blockages, inefficiencies and plant failures[5].

#### 1. Combustion[6][7]

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|---|---|
| **Description** | This process involves thermally treating waste in the presence of oxygen at high temperatures, directly releasing the embedded energy in waste. Combustion temperatures are usually in excess of 800℃. Historically, this technology has been the most popular method of thermally treating waste. |
| **Input** | Pre-treated municipal waste. |
| **Outputs** | - Energy which can be used directly in systems requiring heat, or to generate steam for the production of electricity;<br>- Bottom ash; and<br>- Emissions. |

[4] Maunsell (2003). Alternatives to Landfill – Cost Structures and Related Issues
[5] UK DEFRA (2013a). Energy From Waste. A Guide to the Debate
[6] WSN Environmental Solutions (2005). Easy Guide to Waste Technologies
[7] UK DEFRA (2013b). Incineration of Municipal Solid Waste

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| **Types of systems in this category** (Appendix 2) | - Fluidised bed combustion;<br>- Moving grate combustion;<br>- Fixed grate combustion; and<br>- Rotary kiln. |

## 2. Other Thermal Treatment

Other types of thermal treatment include pyrolysis and gasification, where waste is thermally treated to generate secondary products such as gas, liquids and/or solids. These products can be used to supply the energy requirements of a range of applications[8].

These types of thermal treatments are beginning to gain recognition as a means of managing the portions of the waste stream that have high calorific values, such as sewage sludge, agricultural wastes, timber, plastics, food waste, green waste, oily wastes, tyres and paper pulp[9] (refer to Section 4.2.1).

### Gasification[10][11][12][13]

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|---|---|
| **Description** | This process involves thermally treating waste with a reduced amount of oxygen at lower temperatures. Depending on the types of technology, this is normally above 600°C. This means the waste does not fully combust. |
| **Input** | Pre-treated municipal waste that has moisture, recyclables and inert materials removed. |
| **Outputs** | - Energy which can be used directly in systems requiring heat, or to generate steam for the production of electricity;<br>- Synthesis gas (syngas) has a net calorific value in the order of 4-10MJ/$Nm^{3*}$ prior to 'clean up';<br>- Bottom ash;<br>- Tar; and<br>- Emissions. |
| **Types of systems in this category** (Appendix 2) | There are many variations to this technology; some include plasma gasification and slagging gasification. |

** Natural gas has a much higher calorific value, at 38MJ/$Nm^3$*

### Pyrolysis[14][15][16][17]

| | |
|---|---|
| **Description** | This process is carried out in an oxygen-free or low oxygen environment, at relatively low temperatures. Depending on the specific technology used, this can range from 300-850°C. |
| **Input** | Pre-treated municipal waste that has moisture, recyclables and inert materials removed. |

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[8] UK DEFRA (2013c). Advanced Thermal Treatment of Municipal Solid Waste
[9] WSN Environmental Solutions (2005). Easy Guide to Waste Technologies
[10] UK DEFRA (2013c). Advanced Thermal Treatment of Municipal Solid Waste
[11] New Energy (2013). Technology
[12] UK DEFRA (2013a). Energy From Waste. A Guide to the Debate
[13] Clean Energy Council (2005). Waste to Energy. A Guide for Local Authorities
[14] WSN Environmental Solutions (2005). Easy Guide to Waste Technologies
[15] Joseph, S. pers. comm. (2000). BioEnergy Systems and Technology
[16] UK DEFRA (2013a). Energy From Waste. A Guide to the Debate
[17] Baskar, Baskar, Ranjit and Dhillon (2012). Biomass Conversion. The Interface of Biotechnology, Chemistry and Materials Science

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|---|---|
| **Outputs** | - Energy which can be used directly in systems requiring heat, or to generate steam for the production of electricity. This technology creates less raw energy than the other processes;<br>- Syngas which has a net calorific value in the order of 10-20MJ/Nm$^3$ prior to 'clean up'. Syngas can be condensed to make oils and liquid fuels;<br>- Bottom ash;<br>- Char (can contain heavy metals); and<br>- Emissions. |
| **Types of systems in this category** (Appendix 2) | There are a number of different pyrolysis applications, such as torrefaction and carbonisation. |

## 4. Application

### 4.1 Where does Waste to Energy fit in the Waste Hierarchy?

There are a number of practical considerations that can greatly influence the final decision on which technology to employ to treat various wastes. These include the locations available to site a facility, markets for outputs, or the required capital[18]. However, it is important that decisions relating to the treatment of waste are made with a balance between the Sustainability Principles and the Waste Management Hierarchy.

Sustainability Principles are used in decision making to ensure that the economic, social and environmental considerations of any particular action are taken into account[19].

The concept of the Waste Management Hierarchy ranks treatment options from the most to least environmentally desirable – with avoidance and minimisation of waste generation as the most desirable options and disposal as the least. In using the Hierarchy, it is important to have an understanding that the disposal options for some wastes are limited by their physical characteristics (e.g. clinical wastes).

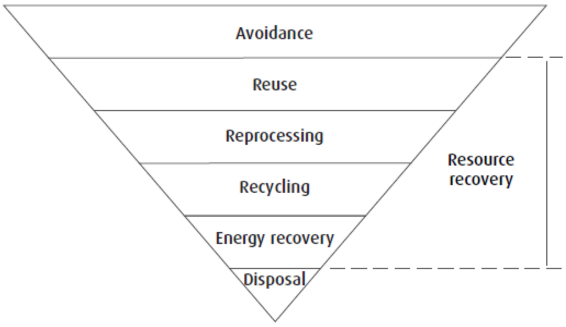


Figure 1: The Waste Management Hierarchy (EPA and Waste Authority, 2013).

In Western Australia, the place of Waste to Energy technologies within the Hierarchy is defined as *"resource recovery (including reuse, reprocessing, recycling and energy recovery)"* by the *Waste Avoidance and Resource Recovery Act 2007.* This is further expanded upon in the advice provided to the Environment Minister by the EPA and Waste Authority (Figure 1)[20]; Recommendation 5: "*The Waste Hierarchy should be applied and only waste that does not have a viable recycling or reuse alternative should be used as feedstock. Conditions should be set to require monitoring and reporting of the waste material accepted over the life of a plant."* It should be noted that, the 2015 and 2020 metropolitan municipal waste diversion targets of the State Waste Strategy are stated as 50% and 65% respectively[21]. To achieve these targets, there is a

[18] Maunsell (2003). Alternatives to Landfill – Cost Structures and Related Issues
[19] WA Department of Premier and Cabinet (2004). WA State Sustainability Strategy
[20] EPA and Waste Authority (2013). Environmental and Health Performance of Waste to Energy Technologies
[21] Waste Authority (2012). Western Australian Waste Strategy: "*Creating the Right Environment*"

need for significant investment in resource recovery infrastructure that will form part of an integrated waste management system.

In Australia, other jurisdictions have also provided guidance on the use of Waste to Energy as part of the Waste Hierarchy. For example, the New South Wales EPA has released a Draft Policy Statement that explicitly addresses the place of thermal technology within the Hierarchy. This direction is also consistent with the policy direction provided in Europe, where residual waste from other resource recovery processes is considered appropriate for use in Waste to Energy plants[22].

*"The NSW Government considers energy recovery as a complementary waste management option for the residual waste produced from material recovery processes or source separated collection systems. In order to ensure energy recovery facilities do not receive as feedstocks, waste materials for which there is an existing higher order reuse opportunity, a resource recovery criteria has been developed for energy recovery facilities*[23]*."*

## 4.2 What are the inputs and outputs for Waste to Energy?

The waste stream that is used in a Waste to Energy process, will determine the characteristics of the residuals and emissions that are generated as outputs.

### 4.2.1 Input: what do you put in?

It is imperative that Local Governments are aware of the composition and characteristics of the municipal waste that will be used in a Waste to Energy facility. The EPA and Waste Authority advice to the Environment Minister recommends that *"Waste to Energy proposals must characterise the expected waste feedstock and consideration made to its likely variability over the life of the proposal."*[24] The calorific value and biogenic content (i.e. the component of materials originating from biological sources) of waste materials will affect the efficiency at which a facility can operate[25]. In Europe, the calorific value of municipal waste that has not been processed is in the order of 8-11MJ/kg[26], whereas waste that has undergone a process to reduce particle size or remove moisture, recyclables and inert materials, is between 12-17MJ/kg[27]. These figures are much lower than traditional fuels such as brown coal, which has a calorific value of 22MJ/kg[28]. Figure 2 provides a comparison of the energy available in various wastes.

[22] UK DEFRA (2012). Waste Incineration Directive
[23] NSW EPA (2013). Draft Policy Statement on Energy from Waste
[24] EPA and Waste Authority (2013). Environmental and Health Performance of Waste to Energy Technologies
[25] UK DEFRA (2013a). Energy From Waste. A Guide to the Debate
[26] UK DEFRA (2013b). Incineration of Municipal Solid Waste
[27] Castaldi, Nickolas, Themelis (2010). The Case for Increasing the Global Capacity for Waste to Energy (WTE). Waste Biomass Valorization
[28] Municipal Engineering Foundation of Victoria (2004). Future Directions in Alternative Waste Technologies

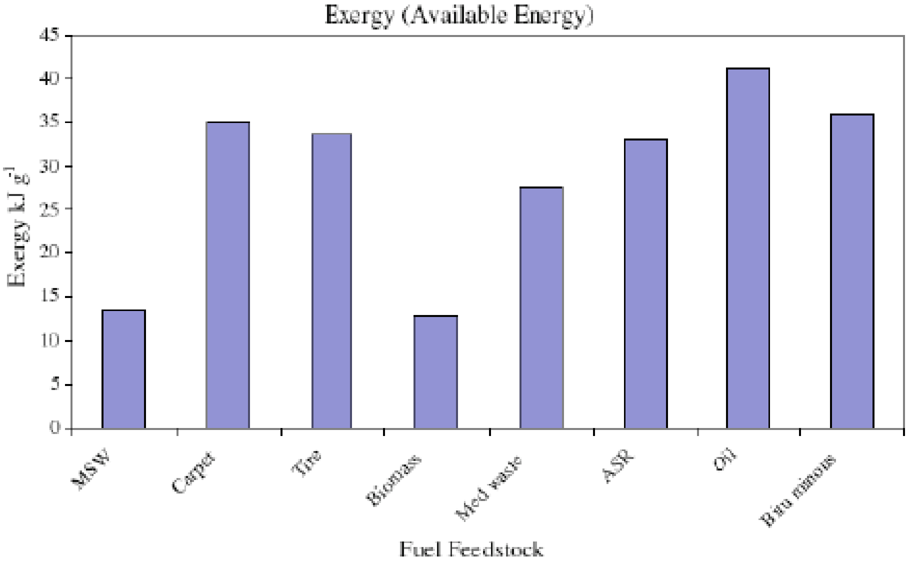


Figure 2. Available energy in several types of waste (Castaldi and Themelis 2010, Figure 10).
(Note: ASR is an acronym for Automotive Shredder Residues)

As previously discussed, Waste to Energy facilities can have the benefit of offsetting non-renewable energy sources such as coal. However, it should be noted that Waste to Energy facilities processing municipal waste in Europe, are only considered to generate partially renewable energy. This is due to the potential for materials containing fossilised carbon (for example, plastic) to enter into the treatment process[29]. This is an important consideration for those developing facilities in Australia, given the current Government incentives and the projected linkage between the Australian and European Union Emissions Trading Schemes[30].

It is also important to take into consideration the likelihood of variation in the composition of waste over the life of the waste delivery contract for a facility. Recommendation 3 of the EPA and Waste Authority's advice to the Environment Minister states that "*Waste to Energy proposals must demonstrate that the waste to energy and pollution control technologies chosen are capable of handling and processing the expected waste feedstock and its variability on the scale being proposed. This should be demonstrated through reference to other plants using the same technologies and treating the same waste streams on a similar scale, which have been operating for more than twelve months.*"[31]

Local Governments considering Waste to Energy technologies need to be aware that Waste to Energy technologies are designed to operate within defined parameters. If the parameters are not met, it is impossible for the facility to function efficiently and generate the expected outputs. This can be overcome by designing contracts with provisions for the facility operators to source material from other avenues that can be mixed with municipal waste to bring the composition back within the required parameters for the Waste to Energy facility. Another important factor for Local Governments to take into account is that Waste to Energy technologies require energy to operate. Should a facility require more energy to operate than originally intended, the energy outputs will obviously be reduced (refer to section 4.2.2).

The following *hypothetical examples* explore some of the scenarios Local Governments may encounter, in the event the points discussed in the preceding paragraphs are not adequately addressed. There are a number of different contractual arrangements a Local Government can enter into, that can assist in mitigating these types of situations.

[29] UK DEFRA (2013b). Incineration of Municipal Solid Waste
[30] Department of Climate Change and Energy Efficiency (2012). Australia and European Commission Agree on Pathway Towards Fully Linking Emissions Trading Systems
[31] EPA and Waste Authority (2013). Environmental and Health Performance of Waste to Energy Technologies

*Example 1: Waste Composition Change*
Over the life of a 20 year waste delivery contract to a Waste to Energy facility, the composition of waste gradually changes. This variation is due to changing demographics in the area, high density housing, less organic material and that residents are disposing of products that did not exist when the contract was initially agreed. The Local Government is in breach of its contractual agreement to supply waste of a certain composition, resulting in a loss of revenue from reduced energy outputs and fines for breach of contract.

*Example 2: New Services*
A Council resolves to introduce a three bin collection system (targeting organics) as an additional resource recovery measure to the pre-existing Waste to Energy facility. The Council is not aware that 15 years prior, the Council committed to supplying a set amount of waste to the facility annually. Introducing the third bin has a direct impact on the biogenic content and amount of material delivered to the Waste to Energy facility. This has resulted in poor performance of the plant, and a reduced capacity to secure carbon credits.

*Example 3: Prolonged Facility Closure*
A Waste to Energy facility experiences an unexpected technical issue with equipment that has been sourced from overseas. This results in significant down time, and closure of the facility. The Local Government supplying waste to the facility does not have a contingency plan in place to deal with the prolonged closure of the facility. The nearest available landfill that can take the material is over 100km away. Taking material this far afield causes delays to residential waste collection. The Local Government is anticipating it will have to pay high fees to send the material to landfill, as well as experiencing a loss of income from a lack of energy outputs. Additionally, there is a considerable amount of negative feedback from the public.

### 4.2.2 Output – what do you get out?

A key consideration in assessing the applicability of Waste to Energy technologies to the municipal waste stream is the overall efficiency of the various technologies. This is based on the amount of energy produced by a facility, net the energy required by the treatment process[32]. For example, a process that exports heat directly for use in another process is more efficient than a process that uses the heat to generate electricity. The following comments should only be considered as a general guide, as there are a range of technology variations that generate a variety of outputs.

As discussed in Section 4.2.1, the composition of the municipal waste that is supplied to a Waste to Energy facility can vary. This can influence how efficiently a facility operates. Using proven technology from the northern hemisphere in the southern hemisphere could result in different rates of efficiency and outputs, due to differing municipal waste feedstock characteristics, and a lack of customers requiring heat.

**Electricity**[33][34]
The thermal treatment of waste is often used to generate electricity. This process involves using the heat from combusted waste materials to produce steam. The steam is used in a turbine to generate electricity. This traditional combustion system has efficiencies in the order of 15-27%. Electricity can also be generated from gasification technologies, but with less efficiency. This is due to the increased energy required to complete the process. However, it is possible to increase the rate of efficiency by also using syngas.

**Heat**[35]
Heat from the combustion process is traditionally used to generate steam. Heat/gas generated from the combustion process, can also be used directly in processes and networks requiring these products. Combusting waste directly in a facility that requires heat has the potential to gain efficiencies in the order of 90%. An example of such a process, is a cement kiln. However, there can be significant challenges in getting this type of business to commit to operating for the life of the Waste to Energy facility.

[32] UK DEFRA (2013a). Energy From Waste. A Guide to the Debate
[33] Castaldi, Nickolas, Themelis (2010). The Case for Increasing the Global Capacity for Waste to Energy (WTE). Waste Biomass Valorization
[34] UK DEFRA (2013a). Energy From Waste. A Guide to the Debate
[35] UK DEFRA (2013b). Incineration of Municipal Solid Waste

**Combined Heat and Power**[36]
This process involves capturing and using the heat that is produced during the process of generating electricity. Employing this type of approach can result in efficiencies of over 40%, which is much higher than a facility designed to capitalise on heat prior to electricity production. However, in considering this approach an assessment of the value, demand and customer base for each of these outputs is required prior to designing a Waste to Energy facility.

**Fuels**[37]
Syngas can also be processed for other uses such as a fuel directly in a gas turbine. There are a number of products that can be created from syngas that have applications in the transport industry. These include biomethane, hydrogen, ethanol, synthetic diesel and jet fuel. In determining which technology to employ, Local Governments need to be mindful that the processes required to purify syngas, depend on energy. This can affect the overall energy outputs of a facility.

There is a possibility that the pyrolysis oil generated from the Pyrolysis process could be used to make petrol and diesel. However, it is important to consider that the process required to make useful fuels with consistent properties is energy intensive.

**Bottom Ash and Char**[38][39][40]
Bottom ash is defined as a residual output from the combustion process (it largely contains the non-combustible elements of the waste feedstock). In a traditional combustion process, the bottom ash is typically 20-30% of the original waste by weight, and 10% by volume. The volume of bottom ash is dependent on the technology employed, and the level of pre-treatment that occurs prior to combustion. As a result, Local Governments considering Waste to Energy technologies will need to consider what end use or method of disposal will be in place for the bottom ash. Recommendation 15 of the EPA and Waste Authority's advice to the Environment Minster states that "*bottom ash must be disposed of at an appropriate landfill unless approval has been granted to reuse this product.*"[41] A reason for this, could be due to the limited markets for using this material in construction and civil engineering processes in Australia.

Slow pyrolysis technology can be used to produce bio-char that can be used to improve soils and sequester carbon.

**Emissions**[42][43]
The emissions that a Waste to Energy facility generates, depends on the technology employed and the composition of material entering the facility. For unprocessed municipal waste, the composition can vary dramatically. Emissions can include sulphur dioxide, carbon monoxide, nitrogen oxide, hydrogen chloride, mercury, and particulates. As a result, the systems required to 'clean up' and monitor the emissions can be as much as 60% of a facility's cost (refer to Section 4.3.1 for more information).

## 4.3 Addressing Community Concerns

A key issue for Local Governments to address in considering employing Waste to Energy technologies is how to involve the community. History demonstrates that when a community is not engaged or adequately consulted in the decision making process for a Waste to Energy proposal, there can be a significant backlash (regardless of the merits of the project). Some of the reasons there can be such a strong reaction, stem from negative experiences with the early forms of Waste to Energy technologies in other parts of the world. Concerns can range from topics such as the health of residents, the amenity of an area, or property values. The following Sections detail some of the concerns raised by communities in response to various Waste to Energy proposals, and an overview of solutions.

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[36] UK DEFRA (2013b). Incineration of Municipal Solid Waste
[37] UK DEFRA (2013c). Advanced Thermal Treatment of Municipal Solid Waste
[38] UK DEFRA (2013a). Energy From Waste. A Guide to the Debate
[39] WSP (5 December 2012). Presentation to WtE Industry Event in Perth, Australia
[40] Gaunt J. and Lehmann J. (2008). Energy Balance and Emissions Associated with Biochar Sequestration and Pyrolysis Energy Production
[41] EPA and Waste Authority (2013). Environmental and Health Performance of Waste to Energy Technologies
[42] MWAC (2009). Alternative Waste Treatment (AWT) Technology Position Paper
[43] Clean Energy Council (2005). Waste to Energy. A Guide for Local Authorities

### 4.3.1 Environmental / Health Impacts

There is often a perception by communities that Waste to Energy technologies are poor performers in the area of environmental health, releasing toxic emissions that cannot be captured or monitored. As such, it is important to demonstrate that significant efforts are directed at establishing internationally recognised processes that either avoid or capture and treat emissions. Additionally, it is important to explain that these processes are regulated and monitored. Showing live time emissions monitoring, via a website, can be one method of achieving this[44][45].

It is also important that communities are made aware of the types of waste that will be treated in a proposed facility. It would appear that facilities recovering resources from uniform, non-hazardous wastes are more likely to gain acceptance than facilities used to treat materials such as Schedule X Pesticides.

As discussed in Section 2, the WA State Government has released its advice to the Environment Minister on Waste to Energy Technologies[46]. This advice identifies that the regulatory framework established by the *Environmental Protection Act 1987* is sufficient to "*minimise and manage the environmental and health risks associated with Waste to Energy plants in Western Australia.*" Some of these regulatory measures include an environmental impact assessment, works approval, licence and supporting conditions. It is important to understand that the advice to the Environment Minister, recommends how the regulatory framework should be applied, and *"provides the basis for the EPA's assessment of current and future proposals*". For example, recommendation 8 requires that "*… waste to energy plants should be required to use best practice technologies and processes. Best practice technologies should, as a minimum and under both steady state and non-steady state operating conditions, meet the equivalent of the emissions standards set in the European Union's Waste Incineration Directive."* There are a number of other recommendations that outline the type of monitoring regimes that are to occur, as well as the information required by proponents of Waste to Energy facilities from the EPA for the approvals process.

### 4.3.2 Long Term Supply Contracts – "Feeding the Beast"

Another issue Local Governments need to address is that long term waste supply contracts can be seen by communities as a disincentive to recycle or recover resources. As discussed in the UK Governments Paper on *Incineration of Municipal Solid Waste*[47], Waste to Energy technologies need to support, not compete with efforts to recycle resources. Section 4.2.1 of this Discussion Paper explores the need for Local Governments to embrace a degree of flexibility in establishing long term supply agreements, to ensure that future initiatives to decrease waste generation and increase recycling are not compromised. Clear legislative settings from the State Government are needed to ensure the community is assured that although Waste to Energy technologies can be a solution for managing waste, it is not the only solution and should form part of an integrated approach to waste management.

## 5. Case Studies

This section is intended to provide information on how Waste to Energy technologies have been used in Australia, and is chiefly sourced from the Clean Energy Council of Australia[48]. It should be noted, that there is very little information available on combustion, gasification or pyrolysis facilities that are using municipal waste as a feedstock (refer to Appendix 3 for the indicative processing costs of various Alternative Waste Treatment facilities).

[44] Montgomery County, Maryland. www.montgomerycountymd.gov
[45] EPA and Waste Authority (2013). Environmental and Health Performance of Waste to Energy Technologies
[46] EPA and Waste Authority (2013). Environmental and Health Performance of Waste to Energy Technologies
[47] UK DEFRA (2013b). Incineration of Municipal Solid Waste
[48] Clean Energy Council (2013). Case Studies

**Green Waste Processing Plant: Stapylton, QLD**

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|---|---|
| **Description** | This facility is located within an area zoned heavy industrial land. The technology used is a Fluidised Bed Combustion system, and has a capacity of 5MW. |
| **Owner** | Green Pacific Energy. |
| **Operator** | TechComm Simulation. |
| **Capital Costs** | $12 million (including costs for planned extensions). The funding mechanism is not readily available information. |
| **Input** | Non-native wood waste, branches and tree trimmings. |
| **Outputs** | The plant produces electricity (via steam), which is sold to Energy Australia under a long-term power purchase agreement. The plant is connected to the local Energex distribution grid. This facility saves approximately 30,000 tonnes of Green House Gas emissions annually. |

**Macadamia Nut Power Plant: Gympie, QLD**

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| **Description** | This facility is located at the *Suncoast Gold Macadamias* processing site. The plant uses waste macadamia shells as fuel to generate steam for the production process. Remaining steam is then used to generate power for export to the grid and has a capacity of 1.5MW. |
| **Owner** | AGL Energy Services (Queensland). |
| **Operator** | Ergon Energy. |
| **Capital Costs** | $3 million. The funding mechanism is not readily available information. |
| **Input** | Approximately 5,000 tonnes of waste macadamia nut shells annually. |
| **Outputs** | The plant produces electricity (via steam). The plant is connected to the local Energex distribution grid. |

**Visy Pulp and Paper Mill: Tumut, NSW[49]**

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|---|---|
| **Description** | The Paper Mill uses a mixture of plantation pine and waste paper to produce unbleached kraft pulp and brown paper. A fluidised bed combustion system turns residual waste from manufacturing operations into energy, which assists in providing the energy requirements of the Mill. This facility has a capacity of 20MW. |
| **Owner** | Visy Paper. |
| **Costs** | In total, investment has been nearly $1 billion. The funding mechanism is not readily available information. |
| **Input** | Approximately 240,000 tonnes of renewable bio-mass fuels such as bark, woodwaste and black liquor (a residue from the pulping process) are supplied to the facility annnually. |
| **Outputs** | The plant produces electricity (via steam). |

[49] Visy Paper (2013). Tumut Kraft Mill

## 6. Conclusion

Waste to Energy technologies have a role to play as part of an integrated waste management system that has due regard for the Waste Management Hierarchy and Sustainability Principles. The process of selecting a Waste to Energy technology, needs to include a number of elements, such as robust economic modelling, variation to waste inputs and outputs, as well as markets for all outputs for the duration of a facility's life. In order to address community concerns and technical challenges, a strong legislative framework is required from the State Government, to guide the use and regulation of this technology in Western Australia. The recommendations of the EPA and Waste Authority are included in Appendix 1.

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Legislation
*Waste Avoidance and Resource Recovery Act 2007*

*Environmental Protection Act 1987*

## Appendix 1: for discussion by MWAC
## Checklist of the Recommendations from the EPA and the Waste Authority's advice to the Environment Minister: *Environmental and Health Performance of Waste to Energy Technologies* (released April 2013)

| Conclusions and Recommendations | | MWAC response |
|---|---|---|
| Con. 1 | Waste to energy plants have the potential to offer an alternative to landfill for the disposal of non-recyclable wastes, with the additional benefit of the immediate capture of stored energy. | Agree – MWAC notes that landfills still have a place in waste management. |
| Con. 2 | It has been demonstrated internationally that modern waste to energy plants can operate within strict emissions standards with acceptable environmental and health impacts to the community when a plant is well designed and operated using best practice technologies and processes. | Agree |
| Rec. 1 | Given the likely community perception and concern about waste to energy plants, a highly precautionary approach to the introduction of waste to energy plants is recommended. | Agree – MWAC suggests that a legislative framework for the use of Waste to Energy Plans is needed. The State Government also has a role to play in addressing community perceptions about the use of this technology. |
| Rec. 2 | As part of the environmental assessment and approval, proposals must address the full waste to energy cycle - from accepting and handling waste to disposing of by-products, not just the processing of waste into energy. | Agree. |
| Rec. 3 | Waste to energy proposals must demonstrate that the waste to energy and pollution control technologies chosen are capable of handling and processing the expected waste feedstock and its variability on the scale being proposed. This should be demonstrated through reference to other plants using the same technologies and treating the same waste streams on a similar scale, which have been operating for more than twelve months. | Agree – however, note that feedstock is likely to vary between nations. |
| Rec. 4 | Waste to energy proposals must characterise the expected waste feedstock and consideration made to its likely variability over the life of the proposal. | Agree. |
| Rec. 5 | The waste hierarchy should be applied and only waste that does not have a viable recycling or reuse alternative should be used as feedstock. Conditions should be set to require monitoring and reporting of the waste material accepted over the life of a plant. | MWAC strongly supports this recommendation. However notes that a triple bottom line approach should also be taken in decision making in this area. |
| Rec. 6 | Waste to Energy operators should not rely on a single residual waste stream over the longer term because it may undermine future recovery options. | Agree – but question the ability of the EPA to enforce. |
| Rec. 7 | Regulatory controls should be set on the profile of waste that can be treated at a waste to energy plant. Plants must not process hazardous waste. | Agree – and request information on the waste profile. |
| Rec. 8 | In order to minimise the discharge of pollutants, and risks to human health and the environment, waste to energy plants should be required to use best practice technologies and processes. Best practice technologies should, as | Agree – however need to ensure that there is clear guidance in WA for operators. |

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| | a minimum and under both steady state and non-steady state operating conditions, meet the equivalent of the emissions standards set in the European Union's Waste Incineration Directive (2000/76/EC). | |
| Rec. 9 | Pollution control equipment must be capable of meeting emissions standards during non-standard operations. | Agree. |
| Rec. 10 | Continuous Emissions Monitoring must be applied where the technology is feasible to do so (e.g. particulates, TOC, HCl, HF, SO2, NOx, CO). Non-continuous air emission monitoring shall occur for other pollutants (e.g. heavy metals, dioxins and furans) and should be more frequent during the initial operation of the plant (minimum of two years after receipt of Certificate of Practical Completion). This monitoring should capture seasonal variability in waste feedstock and characteristics. Monitoring frequency of non-continuously monitored parameters may be reduced once there is evidence that emissions standards are being consistently met. | Agree. MWAC suggests that monitoring requirements during the initial stages of the project should be more prescriptive. |
| Rec. 11 | Background levels of pollutants at sensitive receptors should be determined for the Environmental Impact Assessment process and used in air dispersion modelling. This modelling should include an assessment of the worst, best and most likely case air emissions using appropriate air dispersion modelling techniques to enable comparison of the predicted air quality against the appropriate air quality standards. Background monitoring should continue periodically after commencement of operation. | Agree. |
| Rec. 12 | To address community concerns, proponents should document in detail how dioxin and furan emissions will be minimised through process controls, air pollution control equipment and during non-standard operating conditions. | Agree. |
| Rec. 13 | Proposals must demonstrate that odour emissions can be effectively managed during both operation and shut-down of the plant. | Agree – MWAC suggests that requirements for odour monitoring be more prescriptive. |
| Rec. 14 | All air pollution control residues must be characterised and disposed of to an appropriate waste facility according to that characterisation. | Agree. |
| Rec. 15 | Bottom ash must be disposed of at an appropriate landfill unless approval has been granted to reuse this product. | Agree – MWAC suggests that the type of landfill appropriate for disposal be clearly identified. |
| Rec. 16 | Any proposed use of process bottom ash must demonstrate the health and environmental safety and integrity of a proposed use, through characterisation of the ash and leachate testing of the by-product. This should include consideration of manufactured nanoparticles. | Agree |
| Rec. 17 | Long term use and disposal of any by-product must be considered in determining the acceptability of the proposed use. | Agree. |
| Rec. 18 | Standards should be set which specify the permitted composition of ash for further use. | Agree – but request information on the standards. |
| Rec. 19 | Regular composition testing of the by-products must occur to ensure that the waste is treated appropriately. Waste by-products must be tested | Agree – but need to ensure that the variability of existing feedstock is taken into account. |

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|---|---|---|
| | whenever a new waste input is introduced. | |
| Rec. 20 | Waste to energy plants must be sited in appropriate current or future industrial zoned areas with adequate buffer distances to sensitive receptors. Buffer integrity should be maintained over the life of the plant. | Agree – However, MWAC believes that steps must be taken to ensure the integrity of the buffers for these plants. |
| Rec. 21 | For a waste to energy plant to be considered an energy recovery facility, a proposal must demonstrate that it can meet the R1 Efficiency Indicator as defined in WID. | Agree – however this will be determined by the feedstock. |

## Appendix 2
## Description of design variations for Waste to Energy technologies

**Fluidised bed combustion:** this technology involves feeding fragmented fuel particles onto a bed of coarse sand particles in a combustion chamber. Air (or oxygen) passes up through holes in the bed[50]. The velocity of the air is controlled so that the particles are fluidised in the air above the bed, resulting in a transfer of energy (heat). The air velocity is influenced by the size of the fuel particles, density and pressure drop across the bed. If the air velocity increases, the bed can become turbulent, and begin to circulate[51]. This approach can be utilised in both atmospheric and pressurised systems[52]. In summary, designs include:

- Bubbling Fluidized Bed Combustion; and
- Circulating Fluidized Bed Combustion.

**Moving grate combustion:** this process has a grate/s that continually moves waste through a combustion chamber, and discharges bottom ash at the end of the process. There are a number of different design types within this category. These include:

- Forward reciprocating;
- Reverse reciprocating;
- Roller; and
- Horizontal.

**Fixed grate combustion:** this process consists of a series of fixed grates for each stage of the process (i.e. drying, combustion and burn-out), with the waste mechanically moved through each stage[53].

**Rotary kiln:** this type of technology covers a range of facilities, from those that completely rotate the waste through the kiln to others that function in an oscillating motion[54].

[50] Baskar, Baskar, Ranjit and Dhillon (2012). Biomass Conversion. The Interface of Biotechnology, Chemistry and Materials Science
[51] Baskar, Baskar, Ranjit and Dhillon (2012). Biomass Conversion. The Interface of Biotechnology, Chemistry and Materials Science
[52] US Department of Energy (2013). Combustion - Fluidized-Bed Combustion.
[53] UK DEFRA (2013b). Incineration of Municipal Solid Waste
[54] UK DEFRA (2013b). Incineration of Municipal Solid Waste

## Appendix 3
## *Indicative* Comparison of Various Alternative Waste Treatment (AWT) Processing Costs[55]

The following table is intended to provide *indicative* processing fees for various types of AWT facilities. In viewing these figures, it is important to have an understanding that the costs largely depend on the specific technology used, and the contractual arrangements that are in place for supplying material to the facilities (refer to Section 2).

| Technology | Processing fee ($AUD) | Number of Facilities |
|---|---|---|
| MBT | 180+ | 200+ |
| Anaerobic Digestion | 200+ | 100+ |
| Organic Compost | 70+ | 1000+ |
| Dry Recycling | 50+ | 5,000+ |
| Energy-from-Waste | 250+ | 1,000+ |
| Processed Engineered Fuel / SRF | 150+ | 500+ |
| Gasification[1] | 500+ | <10 |
| Pyrolysis[2] | - | 0 |
| Biochar[3] | - | 0 |

[1] $1 billion investment written off 1995-2005. In Japan the gate fee is $500 p/t.
[2] $1 billion investment written off.
[3] Commercially unproven.

[55] WMAA (2011). Issue 41, Inside Waste. Procuring Sustainable Advanced Resource Recovery Technologies for Councils