12. Alternative Resource Conversion

12.1 Purpose

The purpose of this chapter is to brief the solid waste professionals, decision-makers and citizens on the state-of-the-art waste processing technologies, potential emerging technologies and their applicability to the local needs, and the potential of these technologies to contribute to the County's overall solid waste management system. There has been a re-emergence of alternative resources conversion technologies over the last few years. The consultants canvassed traditional and emerging companies to understand the viability of these technologies, their costs, and where they are being considered.

This chapter will review alternative conversion technologies that can divert material away from traditional landfill disposal to a process whereby the selected waste stream can be converted to a beneficial product. Both on the research tour and in its meetings, SWRAC learned about waste-to-energy (WTE), gasification, and anaerobic digestion. During the field research phase of the County's investigations, meetings occurred between the County and Maui Electric Company to discuss the area's long-term energy demands and how Maui's waste stream may play a part in supplying some portion of those demands. The findings of this discovery are reviewed in this chapter. Further, SWRAC made specific recommendations to initiate a feasibility study with specific parameters. This is discussed in this chapter. Finally, a timeline to achieve SWRAC's recommendation is provided below.

12.2 Legislation

This section summarizes the legislation that applies to WTE and alternative conversion technologies. Also, some of the substantial reductions in environmental impacts of these technologies because of recent legislation are described. Energy-related legislation is very active and should be monitored by the County for applicability to the economics of alternative resource conversion technologies in Maui County.

12.2.1 Federal Legislation

Federal legislation which applies to WTE facilities addresses the air emissions and the disposal of ash. The main laws include the Clean Air Act which sets standards that apply to emissions, the Clean Water Act that covers any liquid discharges, and RCRA which addresses testing and disposal of any solid residues. Each of these has regulations that are administered by U.S.EPA. Alternative energy facilities using waste as a feedstock must be assumed, until proven otherwise, to fall under these same regulations. These subjects are discussed in some detail in Section 12.6.

12.2.2 State Legislation

The State of Hawaii's Department of Health has been authorized by the USEPA to enforce and implement Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act regulations within the State's borders. Hawaii Administrative Rules pertaining to solid waste incinerators and refuse-derived fuel processing facilities can be found in Title 11, Chapter 58.1, Section 11-58.1-20.

Renewable Portfolio Standard

Incentive Type: Renewables Portfolio Standard
Policy Level: State
Province/Territory/State: Hawaii

On June 2, 2004, with the signing of SB2474 SD3 HD2 (Act 95, Session Laws of Hawaii 2004), Hawaii's existing renewable portfolio standard (RPS) goal was replaced with an enforceable standard.

Under Hawaii's original RPS goal, which was established by Act 272, SLH 2001, electricity from renewable resources were to be generated as follows:

1. 7% of its net electricity sales by December 31, 2003;
2. 8% of its net electricity sales by December 31, 2005;
3. 10% of its net electricity sales by December 31, 2010;
4. 15% of its net electricity sales by December 31, 2015; and
5. 20% of its net electricity sales by December 31, 2020.

"Renewable energy" means electrical energy produced by wind; solar energy; hydropower; landfill gas; waste-to-energy; geothermal resources; ocean thermal energy conversion; wave energy; biomass, including municipal solid waste; and biofuels, or fuels derived from organic sources, hydrogen fuels derived from renewable energy, or fuel cells where the fuel is derived from renewable sources.

Source: http://www.dsireusa.org/

Interconnection Standards

Incentive Type: Interconnection
Policy Level: State
Province/Territory/State: Hawaii

Eligible Renewable / Other Technologies: Solar Thermal Electric, Photovoltaics, Wind, Other Distributed Generation (DG), Biomass, Landfill Gas, Hydro, Geothermal Electric, Municipal Solid Waste, Cogeneration, Fuel Cells

Applicable Sectors: Industrial, Commercial, Residential, Federal Government, Nonprofit, Schools, State Sector

Hawaii has established both simplified interconnection rules for small renewables and, more recently, separate rules for all other distributed generation (DG). Simplified interconnection and net metering are available for solar, wind, biomass and hydroelectric systems up to 50 kilowatts (kW) in capacity.

The state's largest electric utility, Hawaii Electric (HECO), which also owns Hawaii Electric Light Company (HELCO) and Maui Electric Company (MECO), uses a set of simple "how-to" interconnection guidelines. HECO also uses a two-page net-metering agreement. A manual, lockable disconnect is required for net-metered systems. There are no additional liability insurance requirements, and a provision for mutual indemnification is included. The state's only other utility, Kauai Island Electric Cooperative, has a similar set of net-metering and interconnection rules.

The interconnection of DG systems is governed by Rule 14, instituted in Hawaii Public Utilities Commission (PUC) Order No. 19773, issued in 2002 and modified in 2003. Rule 14 includes, by reference, the utilities' technical interconnection standards (Appendix I), interconnection agreement (Appendix II) and interconnection procedures (Appendix III). The rules cover all DG technologies.

Appendix I states that a manual disconnect is required for all installations, and a dedicated transformer may be required by the utility depending on the short circuit contribution of the DG device. Interconnection with network distribution systems (as opposed to radial systems) is addressed, although it is unclear when additional studies would be needed to address such interconnections.

In October 2003, the PUC initiated a new proceeding (Docket No. 03-0371) to review and improve the state's DG interconnection rules. This proceeding is still under way.

Source: http://www.dsireusa.org/

2008 Regular Session Bills

The Hawaii State Legislature shall be reviewing a number of house and senate bills in the 2008 Regular Session related to renewable energy. Theses bills have been carried over from the 2007 Regular Session. Below are some of the Senate and House Bills that will be scheduled for the 2008 Regular Session related to renewable energy:

Senate Bill 986
Measure Title: RENEWABLE ENERGY TECHNOLOGY; INCOME TAX CREDIT.
Report Title: Renewable Energy Technology; Income Tax Credit
Description: Establish that all energy technology systems must be installed and placed in service in the State of Hawaii to obtain energy tax credit.

Senate Bill 1065
Measure Title: RELATING TO RENEWABLE ENERGY.
Report Title: Renewable Energy; Fossil Fuel Plants; Prohibition
Description: Prohibits new construction of power plants that produce energy by using fossil fuels.

Senate Bill 1076
Measure Title: RELATING TO RENEWABLE ENERGY.
Report Title: Renewable Energy;
Description: Amends the definition of renewable energy to remove the fossil fuel quotient from renewable energy in determining the amount of energy that counts as renewable energy.

Senate Bill 1375
Measure Title: RELATING TO RENEWABLE ENERGY.
Report Title: Renewable Energy; Increased Use; Public Utilities Commission
Description: Requires the public utilities commission to consider the need for increased renewable energy use. (SD1)

Senate Bill 1395
Measure Title: RELATING TO FORMATION OF A RENEWABLE ENERGY FACILITIES SITING COUNCIL.
Report Title: Renewable energy council
Description: Creates a state renewable energy facilitates siting council.

House Bill 46
Measure Title: RELATING TO RENEWABLE ENERGY.
Report Title: Renewable Energy Electric Generation Cooperatives
Description: Provides for the organization of renewable energy cooperatives to generate, transmit, and sell electricity to their membership. Authorizes issuance of revenue bonds to finance costs related to constructing, upgrading, and acquiring transmission facilities. Exempts cooperatives from Public Utilities Commission regulation, except for interconnection agreements.

House Bill 640
Measure Title: RELATING TO ENERGY.
Report Title: Hawaii Energy Enterprise Zones
Description: Establishes energy enterprise zones to encourage the development of renewable energy resources.

House Bill 737
Measure Title: RELATING TO ALTERNATE ENERGY DEVELOPERS.
Report Title: Taxation; Tax Credit; Alternate Energy
Description: Provides a tax credit to developers of alternate energy.

House Bill 1289
Measure Title: RELATING TO RENEWABLE ENERGY.
Report Title: Renewable Energy Technology; Income Tax Credit
Description: Establishes that all energy technology systems must be installed and placed in service in the State of Hawaii to obtain the State's income tax energy tax credit; changes tax credits applicable to shareholder pro rata shares in S corporations. (SD3)

12.3 Review of Previous Plan

The 1994 ISWMP that the County submitted to and was accepted by the State does not discuss the topic of alternative resource conversion.

12.4 Implementation of Previous Plan

Since no programs on this subject were proposed in the previous plan, the County has not implemented anything regarding alternative resource conversion.

12.5 Summary of Alternative Resource Conversion

12.5.1 Waste-to-Energy (WTE)

12.5.1.1 Background

The WTE industry in the United States represents $14 billion of productive assets from a total of eighty-nine (89) WTE facilities. These U.S. facilities handle up to 15 percent of the country's MSW. Both the geographically large continent of Europe and the relatively small country of Japan exceed these numbers as Table 12-1 below illustrates.

Table 12-1 – WTE Facilities by Location

Location	Number of Facilities	Amount of MSW Managed by WTE as a Percent of Total MSW Generated
USA	89	8-15% based on EPA & *BioCycle* data
Europe	400	Varies from country to country
Japan	100	70 to 80%
Other Nations (Taiwan, Singapore, China, etc.)	70	Varies from country to country

From the mid-1970s to the mid-1980s, WTE facilities developed in the U.S. primarily out of an expectation of increasing energy costs derived from the 1973-1974 energy crisis in the U.S. The Federal Government initiated tax incentives to stimulate growth in the development of non-fossil fuel energy alternatives. These tax incentives provided accelerated depreciation on plants and equipment, a 10 percent energy tax credit, and investment tax credits that could amount to 40 percent of the cost of a facility. These initiatives, however, were done away with under President Ronald Regan's 1986 Tax Reform Act.

The reasons vary as to why other parts of the world have chosen to pursue WTE as a waste management alternative to disposal more than the U.S. One cause may simply be a lack of space. Both Europe and Japan, for example, have less land from which to develop a landfill, let alone a mega-landfill that can accommodate three or more thousand tons per day and have adopted policies opposing this type of land use. Land in the U.S. is relatively inexpensive, with respect to Europe and Japan, but also abundant in supply. The difference in capital cost between a WTE and cheap, abundant land is a significant factor in U.S. jurisdictions choosing to landfill; a benefit the County of Maui does not share with most of the U.S.

A second cause for U.S. jurisdictions not choosing WTE was the loss of ordinance-based flow control with the 1994 U.S. Supreme Court decision in Carbone versus Clarkstown. This decision effectively eliminated many a jurisdictions' sense of security in having the waste resources to efficiently operate a WTE. Since the capital expense is high for a WTE, a jurisdiction had to be concerned about controlling the correct amount of resources to feed it in a cost-efficient fashion.

The Federal Government imposed more stringent air quality standards on WTE, making WTE facilities more capital intensive compared to the much cheaper option of landfill disposal and other energy generators that did not have to meet the new standards. The Federal Government instituted guidelines for municipal combustion residue monitoring, sampling, and testing that, given the growing risk in supply of waste to feed a WTE, caused municipality policy makers to shy away from WTE as a viable option.

Within the U.S., the business of WTE diminished drastically since the 1994 U.S. Supreme Court decision, and many companies stopped building WTE plants. Those companies now left that have experience building such facilities are Covanta Energy, Energy Answers, Montenay Power (now Veolia), Barlow Projects, and Wheelabrator Technologies.

Since 2005, interest in building WTE facilities in the U.S. has fomented for several reasons. First, the cost of oil has increased and currently hovers around $100 per barrel. The higher the cost of energy, the more cost competitive a WTE facility. The combination of sale of electricity and tipping fees can make a WTE facility profitable. A power sales agreement between a jurisdiction and the electric utility purchasing the electricity produced by a WTE facility is important to the economic well-being of a WTE facility.

Interest in building WTE facilities in the U.S. has also increased with the Supreme Court's recent reversal, or, at least, new statement on the Carbone decision. In the Supreme Court's 2007 affirmation of the U.S. Court of Appeals for the Second Circuit's ruling in the case of United Haulers Association Inc. et al. versus Oneida-Herkimer Solid Waste Management Authority et al., the Court concluded, in a split decision, that the counties' flow control ordinances, which treat in-state private business interests exactly the same as out of state ones, do not discriminate against interstate commerce.

Jurisdictions, such as the Counties of Kauai and Hawaii, are looking more closely at the possibility of implementing a WTE strategy to handle their respective post-recycling waste streams. Communities on the mainland, such as King County, Washington and Los Angeles County, California, are also reviewing WTE options. Several locations are in the midst of procurements for WTE such as Carroll, Frederick and Harford Counties in Maryland. Two locations with WTE facilities, Lee County and Hillsborough County, Florida, have recently approved and started construction on an additional process line to their facilities. Additionally, the City and County of Honolulu has announced it will pursue the expansion of its H-Power WTE facility.

The following sections describe proven technologies which have been in commercial use for decades.

12.5.1.2 Mass-Burn/Waterwall Combustion

12.5.1.2.1 Process Description

In mass-burn waterwall combustion, MSW is placed directly into the system for incineration with no pre-processing, except for removal of large identifiable non-burnable items (refrigerators, washing machines, microwave ovens, etc.). Waste is placed onto a grate at the bottom of a combustion chamber in a furnace with walls built of water tubes, as shown in Figure 12-1.

Figure 12-1 - Waterwall Furnace Section[1]

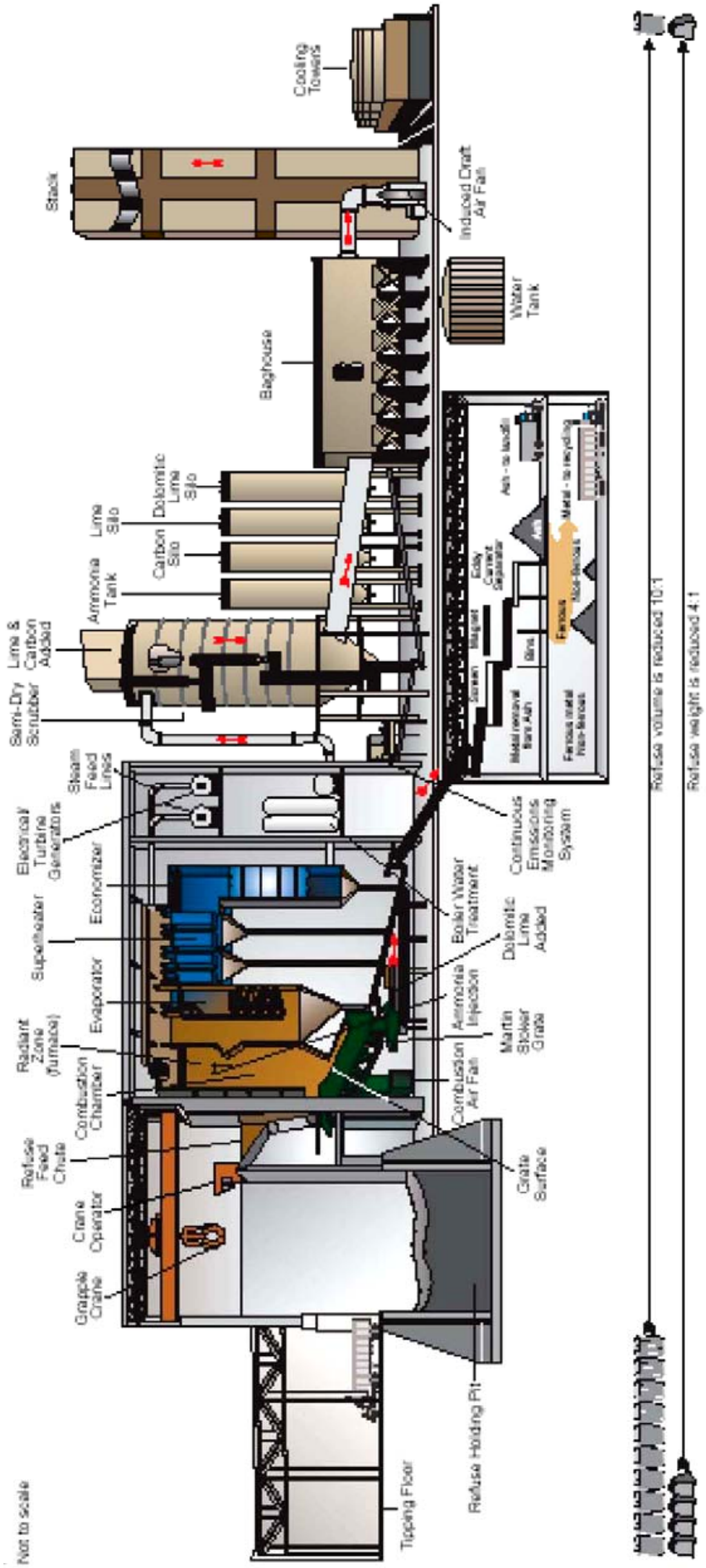
Half the heat generated from the burning waste is absorbed by the water walls and the balance heats water in the boiler, as shown on the illustration in Figure 12-2.

The off-gas exiting the boiler passes through an air pollution control system where the majority of pollutants is removed with the processed gas discharged through a stack to the atmosphere. Waste is burned out to an ash in the furnace. Heat extracted from the waterwalls and the boiler section generates steam, which, in most facilities, is directed to a turbine generator for electric power production.

Waterwall systems are fabricated on-site. They are generally applied to larger systems, 200 TPD, up to 750 TPD, and multiple units are used when higher capacity is required. They are forgiving in their operation, and are reasonably efficient in the burnout of waste and in the generation of energy.

[1] Source: Babcock and Wilcox.

Figure 12-2 - Typical Mass-Burn Waterwall System[2]



2 Source: Fairfax County, VA.

12.5.1.2.2 Worldwide Experience and Vendors in U.S.

No new greenfield mass-burn WTE facilities have been built in the United States since 1997, although there have been acquisitions and ownership and operator changes at certain existing facilities, as well as some plant expansions. As a result, the firms associated with mass-burn WTE are either operators or owners of existing facilities. As shown in the Table 12-2, Covanta and Wheelabrator own and operate the majority of privately-owned WTE facilities. Most of the WTE plants, both public and private, are operated by Covanta, Montenay/Veolia or Wheelabrator.

Table 12-2 – Ownership of U.S. Mass-Burn/ Waterwall Facilities[3]

Entity	Owned	Operated
Public	39	12
Covanta	11	27
Montenay/Veolia	2	9
Wheelabrator	10	16
Other	3	1
Total	65	65

Some of the mass-burn technology had been purchased from American firms such as Detroit Stoker, Combustion Engineering and Babcock & Wilcox, but the majority of these existing systems are of European design. The two leading suppliers of WTE grate systems in the United States and overseas are The Martin Company of Germany and Von Roll of Switzerland.

While new WTE facility procurements have declined in the United States, the market for this equipment has increased in Europe and in Eastern Asia, with European and Japanese systems suppliers actively marketing their systems, and consistently improving their performance. This technology is well tested and is used more than any other for large WTE facilities in the United States and overseas.

12.5.1.3 Mass-Burn/Modular Combustion

12.5.1.3.1 Process Description

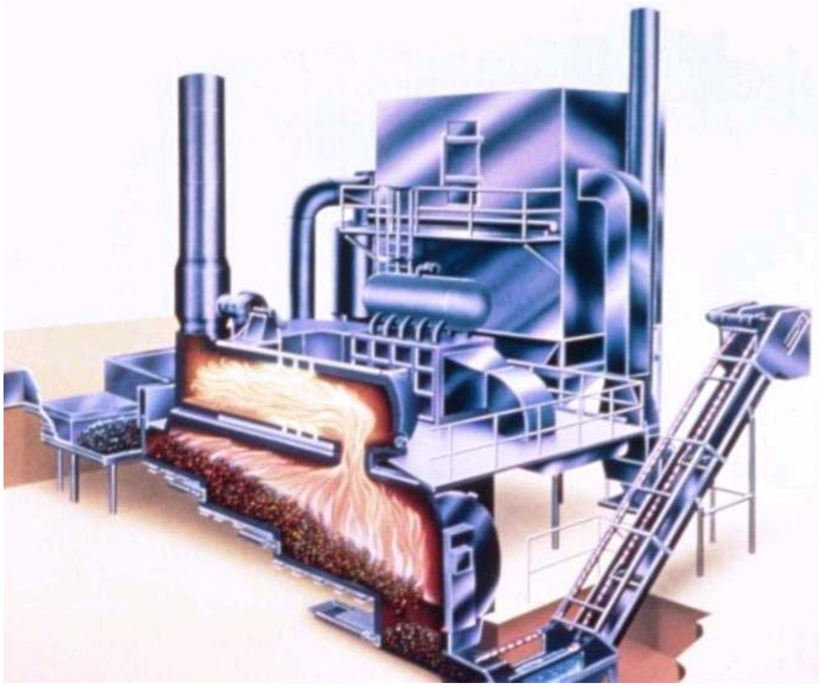
Modular combustion is a similar incineration process. Unprocessed MSW is placed directly into a refractory lined chamber. The primary chamber of the incinerator includes a series of charging rams which push the burning waste from one level to another until it burns out to an ash and is discharged to a wet ash pit, as shown below.

Less than the ideal amount of combustion air is injected into the primary combustion chamber, and the gas from the burning waste does not fully burn out at this location. It is directed to a secondary combustion chamber where additional air is added to complete the burning process. Hot gases pass though a separate waste heat boiler for steam generation, and then through an air pollution control system, before discharge through the stack to atmosphere. A schematic of a modular system is shown in Figure 12-3.

[3] Integrated Waste Management Services Association, 2004 Directory of WTE Plants.

A major advantage of this system is injection of less air than ideal in the primary combustion chamber. With less air, the fans can be smaller and the chamber itself can be smaller than with other systems. Also, with less air flow, less particulate matter (soot) enters the gas stream and the air pollution system can be sized for a smaller load.

Figure 12-3 - Typical Modular Combustion System[4]



Modular systems are factory built and can be brought to a site and set up in a relatively short period of time. They are less efficient than waterwall units in waste burn-out and in energy generation. They have been built in unit sizes up to 150 TPD.

12.5.1.3.2 Worldwide Experience and Vendors in U.S.

Modular systems are used for smaller WTE facilities and for industrial applications. Unlike Mass-burn/waterwall systems, there are a number of American firms supplying such systems in the United States, and they are very competitive in overseas markets as well. The more active of these suppliers are Consutech Systems of Richmond, Virginia, Enercon Systems, Inc. of Elyria, Ohio, and Basic Environmental Engineering of Chicago. They have each been supplying incineration systems for MSW and other wastes for over 25 years.

Other U.S. firms, such as Energy Answers of Albany, NY, and Covanta Energy of Fairfield, NJ, are marketing management services for WTE modular facilities.

12.5.1.4 Refuse-derived Fuel/Dedicated Boiler

12.5.1.4.1 Process Description

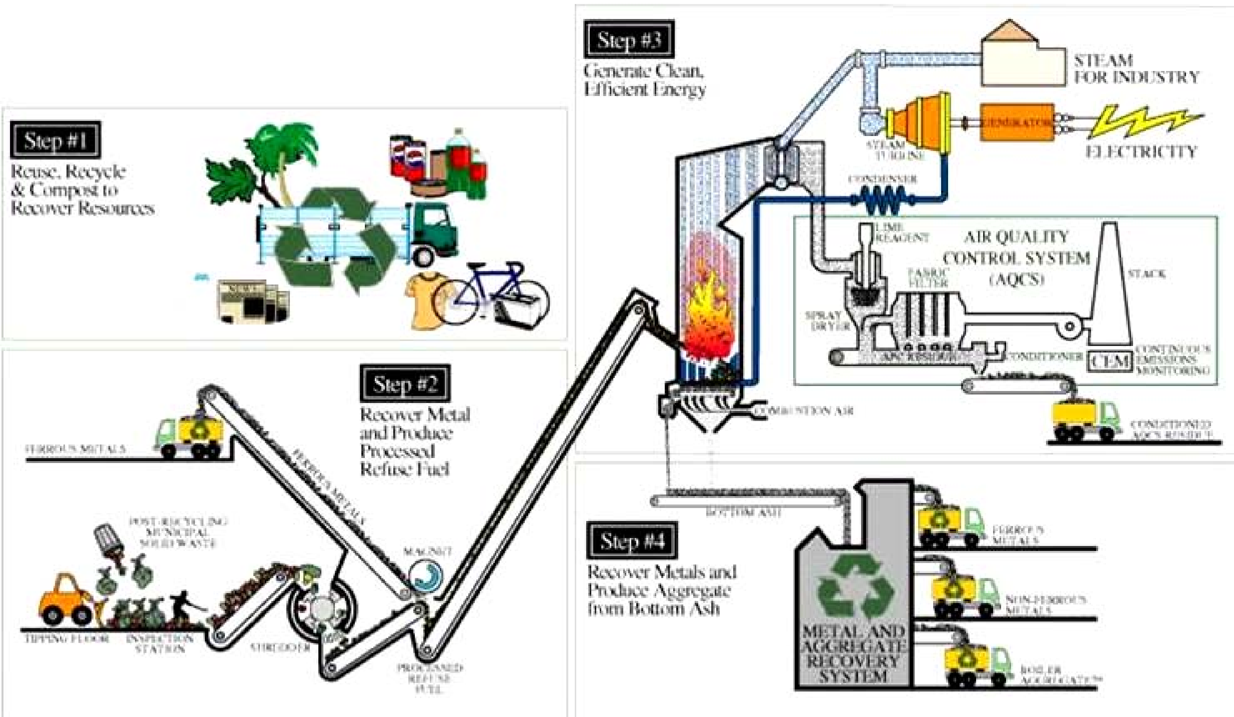
Refuse-derived Fuel ("RDF"), in its simplest form, is shredded MSW with ferrous metals removed. Additional processing can be applied to the incoming waste stream,

[4] Source: Consutech Systems, Richmond, VA.

such as removal of glass and aluminum, or additional shredding stages can be placed in the processing line to match RDF particle size to firebox residence time.

As shown in Figure 12-4, RDF is blown into the furnace from the left, above the grate. What does not burn in suspension (above the grate) will burn on the grate, and the hot gases generated will pass through a waterwall section and then a boiler section. This system is similar to the Mass-burn waterwall facility except in the nature of waste charging and burnout.

Figure 12-4 - Typical RDF Combustion Facility[5]

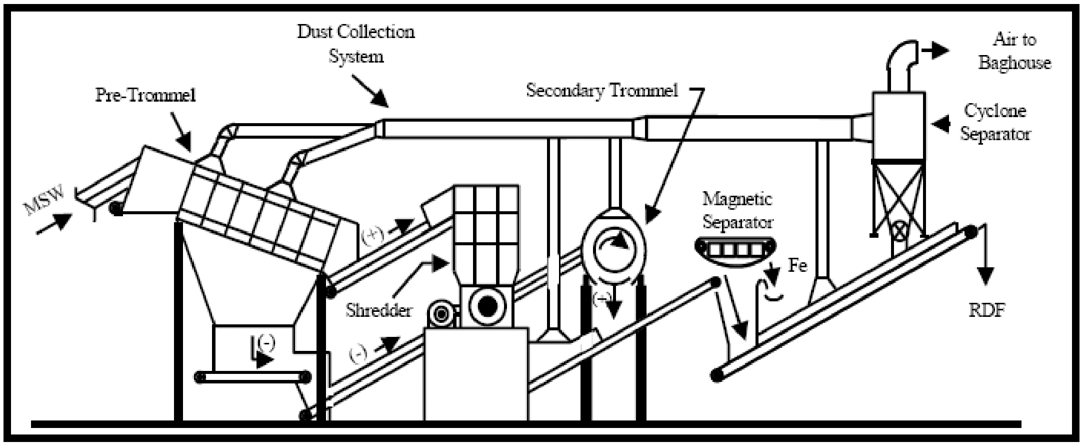


The unique feature of RDF systems is in the pre-processing of waste. As seen in the following diagram of a typical RDF processing facility, MSW enters the facility and then passes through a pre-trommel, where bags of waste are broken open. Materials dropping out of the pre-trommel pass through another trommel, but the majority of waste go through a shredder. A magnetic separator removes ferrous metals and the balance of the material is fired in the furnace.

Other configurations may include additional separating equipment, or may not use any trommels, but the RDF generated is always shredded, so that it is capable of being blown into a furnace. Figure 12-5 shows the processing flow of an RDF facility.

[5] Source: Energy Answers Corporation.

Figure 12-5 - Typical RDF Processing Facility[6]



An advantage of this system is in the removal of metals and other non-combustible materials from the waste stream. While not all these facilities include this step in the processing line, those that do can realize revenue from the sale of recovered metal. With the removal of non-combustibles, the specific heat content of the RDF can be increased by 10 percent over the original MSW, thereby generating more electricity per ton processed for conversion.

12.5.1.4.2 Worldwide Experience and Vendors in U.S.

As with Mass-burn systems, there have not been any new RDF systems constructed in the United States in the past decade because of the reasons already listed (e.g. loss of tax credits, low oil cost, cheap land). Of the 12 RDF WTE facilities currently in operation, Xcel and Covanta Energy are the operating contractors of most of these systems. One of these facilities is in Hawaii; the City and County of Honolulu contracts with Covanta to operate its H-power RDF WTE facility located in the Campbell Industrial Park. The facility, which began operation in 1990, processes 600,000 tons of waste annually, producing seven percent of Oahu's electricity.

However, this technology is the mainstay of coal-fired electricity generation plants, and there are many established U.S. system and equipment suppliers, such as Foster Wheeler, Riley, Babcock and Wilcox and Combustion Engineering.

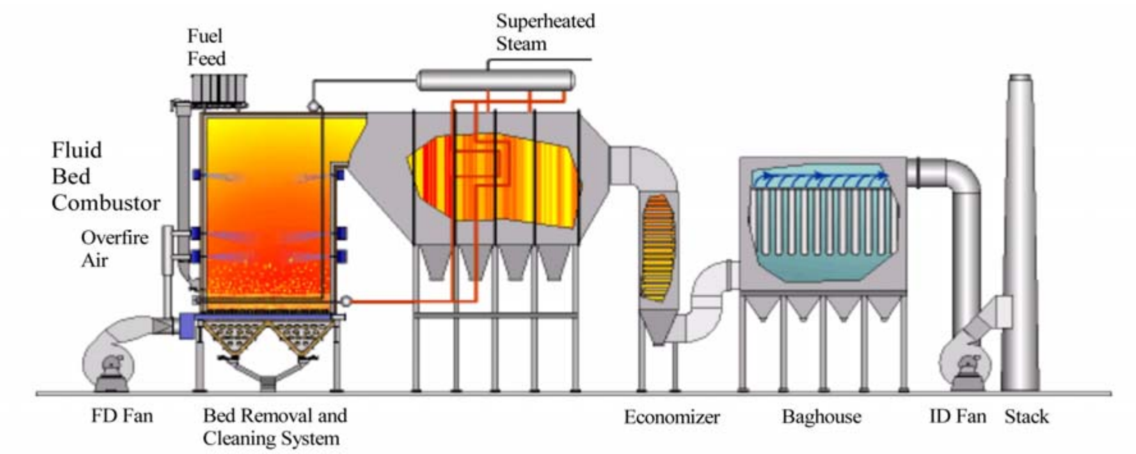
12.5.1.5 Refuse-derived Fuel/Fluidized Bed

12.5.1.5.1 Process Description

In this incineration process, MSW is shredded to less than four inches mean particle size (the same as with the RDF process described above) but is blown into a bed of sand in a vertical cylindrical furnace. Hot air is also injected into the bed from below, and the sand has the appearance of a bubbling fluid as the hot air agitates the sand particles. Moisture in the RDF is evaporated almost instantaneously upon entering the bed, and organics burn out both within the bed and in the freeboard, the volume above the bed. Steam tubes are embedded within the bed and a transverse section of boiler tubes captures heat from the flue gas exiting the furnace, as shown in the illustration in Figure 12-6.

[6] Source: generic.

Figure 12-6 - Typical RDF Fluid Bed System

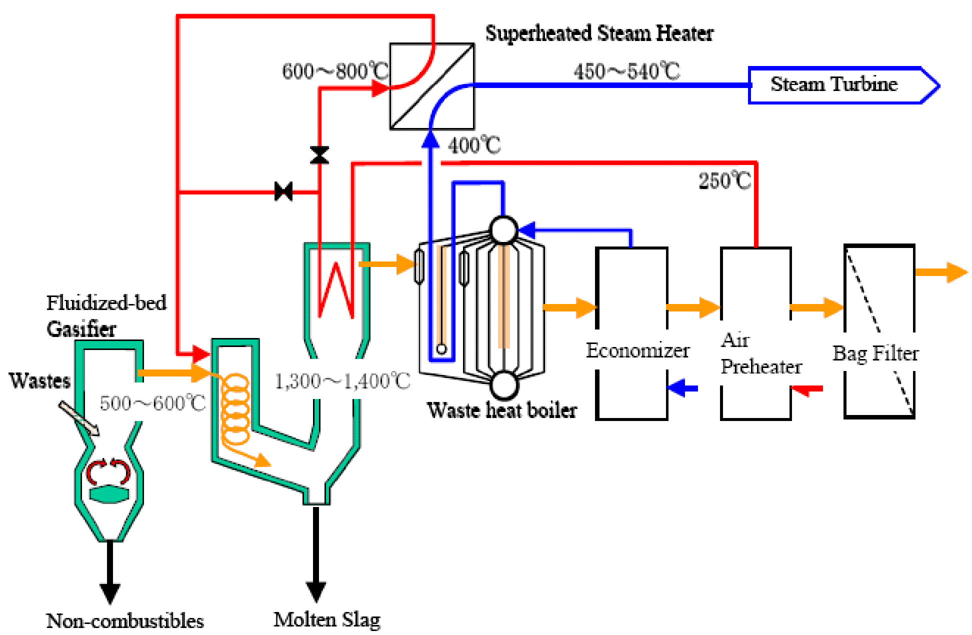


Fluid bed incineration is more efficient than grate burning-based incineration systems. The bed is very effective in waste destruction and requires less air flow than mass-burn or modular systems. The fluid bed, however, does require relatively uniform sized material, and RDF preparation is necessary.

A variation of the fluid bed system described above is the fluidized-bed gasifier, shown in Figure 12-7.

Although this system is described as gasification technology, it does not export a burnable gas. RDF is charged to the fluid bed and the gas generated is directed to a combustion chamber, shown above, with molten slag dropping out to a water-cooled sump. The molten slag solidifies into a glass-like material which can be used as a construction material or fill. Heat from the gas fired in the combustion chamber will be captured in hot water tubes to generate steam which can be used for electric power generation.

Figure 12-7 - RDF Fluidized Bed Gasification System[7]



[7] Source: Ebara Corporation, Tokyo.

12.5.1.5.2 Worldwide Experience and Vendors in U.S.

While there are several RDF/fluid bed systems operating in Europe (particularly in Scandinavia, where a number of fluid bed incinerator manufacturers are located), there is only one such facility in operation in the United States: French Island, WI. It is owned and operated by Xcel Energy of Minneapolis. The equipment was supplied by Energy Products of Idaho in Coeur d'Alene, the only U.S. firm currently manufacturing furnaces for RDF firing.

The RDF-gasification technology described above is a product of Ebara Corporation of Tokyo. They have four such systems in operation on MSW in Japan, ranging in size from 185 TPD to 460 TPD.

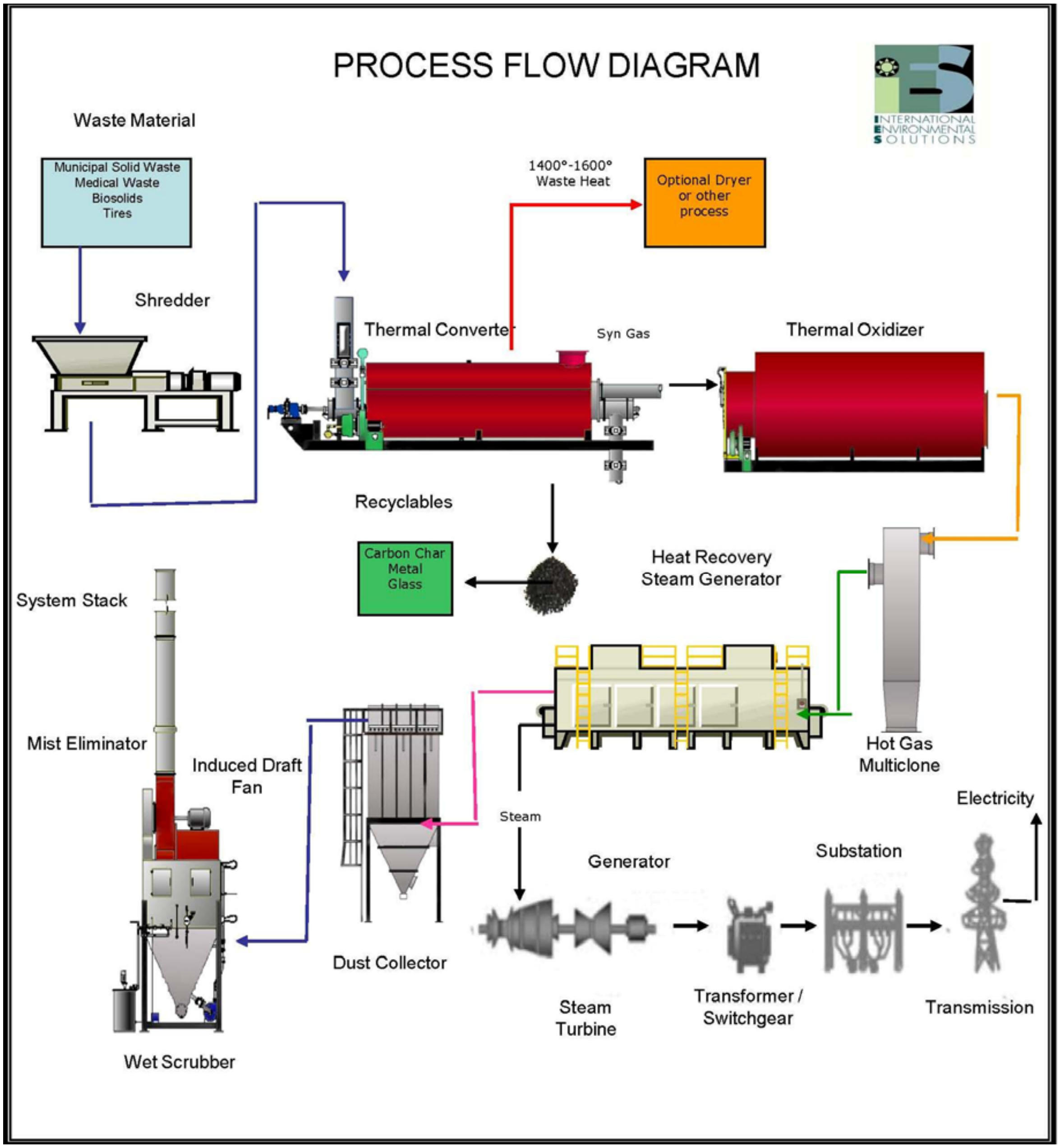
12.5.2 Emerging Waste Technologies

12.5.2.1 Pyrolysis

In pyrolysis, an organic waste (MSW) is heated without oxygen (or air), similar to the generation of coke from coal or charcoal from wood. Both a char and a gas are generated. The gas is burned out in a gaseous phase, requiring much less oxygen than incineration, and the char will usually melt at the temperatures within the pyrolysis chamber and will be discharged as a black gravel-like substance, termed frit. Advantages of this process are in the lack of air entering the chamber and the resulting smaller size of system components. Without air, there is little nitrogen oxides generation, and low particulate (soot) formation. There have been many attempts to develop this technology outside a laboratory or a pilot plant. In past demonstrations in the 1970s, it was difficult to maintain a sealed chamber to keep air out, and waste variability creates problems in maintaining consistent operation. When the pyrolysis gas is fired in a combustion chamber that is part of the system, the system is classified as an incinerator. Currently, there are no full-scale pyrolysis systems in commercial operation on MSW in the United States.

A pilot demonstration system has been operating in southern California for a number of years. It was built and is operated by International Environmental Solutions, of Romoland, CA. As shown in Figure 12-8, it shreds MSW down to a uniform size capable of feeding into the thermal converter, or pyrolysis chamber. The pyrolysis gas generated is fired in a secondary combustion chamber, or thermal oxidizer, and passes through a waste heat boiler for heat recovery. Char drops out the bottom of the pyrolysis chamber for disposal or further processing for recovery of metals and other constituents. Although this system is marketed as a pyrolysis system, a combustion chamber is necessary for its operation (for destroying organics in the off-gas) and the presence of this chamber classifies the system as an incinerator.

Figure 12-8 - Process Diagram of a Pyrolysis System[8]



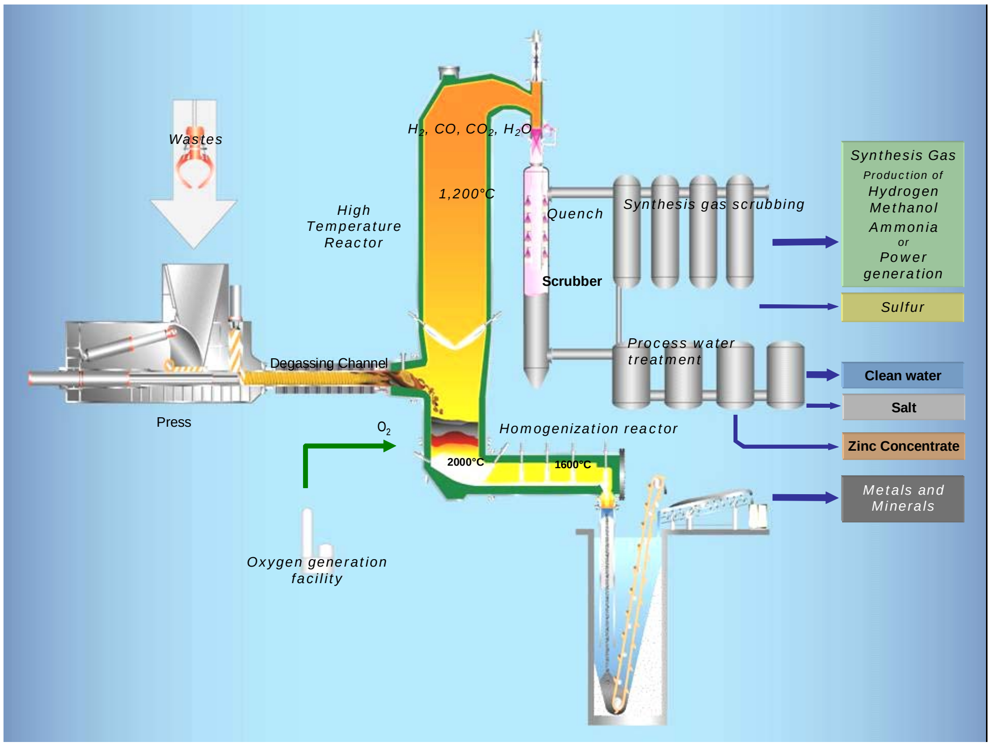
12.5.2.2 Gasification

In times of fuel shortages, gasification approaches become popular. During World War II, for instance, over a million vehicles in Europe ran on gasification by making fuel from wood and charcoal. The rubric heading “gasification” describes processes that use heat to transform solid biomass into a clean burning, carbon neutral, natural gas like flammable fuel. The following reviews some of the key processes that work under the umbrella classification called gasification.

[8] Source: Integrated Energy Systems, Inc., Romoland, CA.

Gasification is the heating of an organic waste (MSW) to produce a burnable gas (approximately 85% hydrogen and carbon monoxide mix) for use off-site. While pyrolysis systems are primarily focused on waste destruction, a gasifier is designed primarily to produce a usable gas. As shown in Figure 12-9, Thermoselect, a European firm represented in the U.S. by Interstate Waste Technologies of Malvern, Pennsylvania, has developed a system composed of 400 TPD modules processing MSW.

Figure 12-9 - Typical Gasification System[9]



Waste is fed into a gasification chamber to begin the heating process, first having been compressed to remove entrapped air. Some oxygen, sufficient only to maintain the heat necessary for the process to proceed, is injected into the reactor, where temperatures in excess of 3,000^{o}F are generated. At this high temperature, organic materials in the MSW will dissociate into hydrogen, methane, carbon dioxide, water vapor, etc., and non-organics will melt and form a glass-like slag. The gas is cleaned, water is removed, and it can be used for power generation, heating or for other purposes. The glass-like slag can be used as fill, or as a building material for roads, etc. The use of such by-products may require regulatory review and approval by the State's Solid Waste Section.

Seven plants with this technology are currently operating in Japan, with at least two of them firing MSW. Their largest facility fires up to 700 TPD of MSW.

Another gasifier marketed for MSW is built by EnTech of Devon, England, and its schematic is shown in Figure 12-10.

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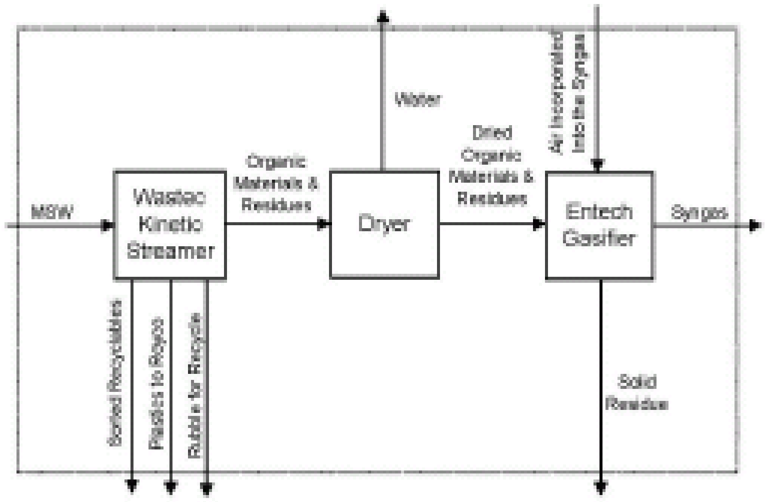
9 Source: International Waste Technologies, Malvern, PA.

Figure 12-10 - EnTech Process Schematic[10]



This is a complex system which generates, in addition to a salable gas (synthetic natural gas, or syngas), recyclable plastics and other potential revenue streams. As shown above, MSW is classified by a combination bag breaker and gravity separator process, termed by EnTech as a Kinetic Streamer. Oversize materials, which are basically inorganic, are directed either to a plastics recycler or a non-plastics recycling station, while the majority of waste (presumably organic) is directed to a dryer to remove entrained moisture. The dryer utilizes the latent heat inherent in the organic content of the waste to produce the heat necessary to drive the gasification process. The syngas can be fired in a waste heat boiler for steam and subsequent electric power production.

Approximately 20 of these facilities using MSW are in operation in Europe and Asia. Most of them are relatively small (less than 10 TPD), with none designed for more than 70 TPD throughput.

12.5.2.3 Anaerobic Digestion

Anaerobic Digestion (AD) has been used for a century to reduce and stabilize biosolids and produce combustible gas in wastewater treatment plants. The process uses waves of microorganisms to do the work. The first wave of microorganisms breaks down the materials in an acidic environment. This process is called hydrolysis. The second wave breaks down the output of the first wave by transforming the fatty acids, acetate, hydrogen, and C02. This second wave is what finally produces the methane biogas.

These microorganisms are reliable and can work within AD systems whether they are wet or dry and hot (thermophilic) or not so hot (mesophilic). Generally the wetter and more mesophilic the system the less energy produced by the AD system. Wet and mesophilic AD systems take 15 to 30 days to process the material while dry and thermophilic AD systems take between 12 and 14 days to process the contents. Finally, AD systems vary in the number of tanks used from both waves working in one tank or multiple tanks.

The microorganisms process biodegradable waste but not items like plastic plates, tires, metals, and a plethora of items found in the MSW. After the biodegradable

[10] Source: www.entech.net.au.

waste is processed and the organic remainder can be composted to produce a marketable product, then the material should be screened to capture such inorganic items and produce a clean consistent product. The premium feed stock, then, for anaerobic digestion, is biodegradable material with a small percentage of inorganic items in the waste stream.

The use of MSW in AD systems has been slow in coming because the processes are more costly than landfilling. But over the past fifteen years as the cost of landfilling MSW has increased in Europe, AD systems have increasingly become operational. The European Union Landfill Directive, for instance, demands the stabilization of organic material, hence has added to the cost incentive as well as creating a legislative fulcrum to advance AD MSW processing. In 1999, 53 AD plants processed about 1 million tons a year of mixed MSW or source separated organics. In 2006, the number of AD facilities jumped to 124 processing 4 million tons of mixed MSW a year.[11]

In North America, only two full-scale AD facilities operate and both are located near Toronto, Ontario, Canada. Toronto organics are taken from 500,000 residential units and 20,000 businesses to the Dufferin Organics Processing Facility. The second facility operates in the same manner but is located outside of Toronto.

In July, SWRAC made a site visit to the only AD facility for source separated organics in the U.S. Onsite Power Systems Inc., located in Davis, California (http://www.onsitepowersystems.com), has a biogas energy test project where eight tons a day of organic waste from homes and restaurants are conveyed into a system of multiple tanks. Each ton of food waste Onsite Power processes can generate enough bioenergy to power and heat ten homes over a 24-hour period.

In Hadera, Israel, the ArrowBio Facility is an AD plant that processes 100,000 tons per year of mixed MSW. This is a 320-TPD facility operating six days per week. The facility is a wet system which separates the recyclables off the top and produces 23,000 tons of compost product and 19,000 tons of residue annually.

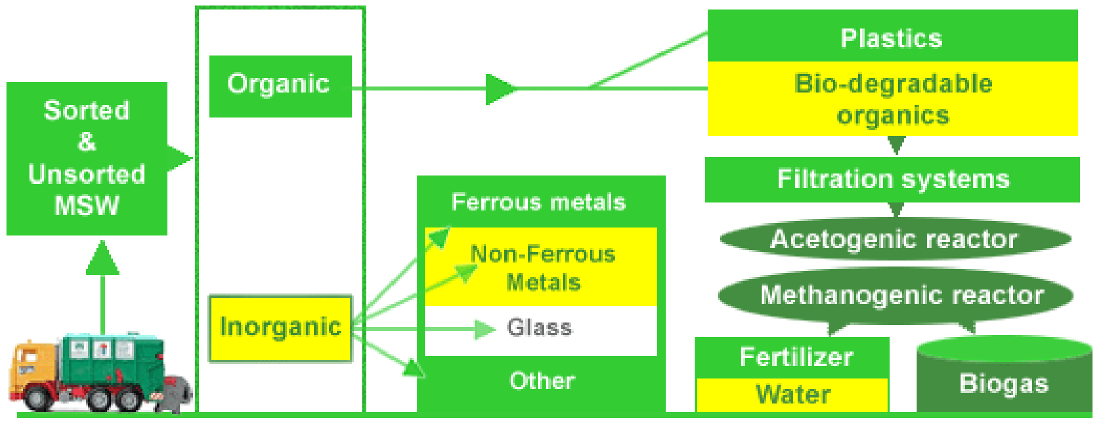
As applied to the processing of MSW, anaerobic digestion is a wet treatment process where waste is first pre-sorted and then fed into water tanks. Using agitators, pumps, conveyors and other materials handling equipment, MSW is wetted and dissolved. Metals, glass and other constituents of MSW that have no affinity for water are eventually discharged from the system into dedicated containers for recycling, further processing or final disposal. The paper, garbage, soluble components, etc., generate a “black water” which has a relatively high organic content. This stream is taken to a series of digesters where the time it sits in the chamber, the residence time, will be sufficient to generate an off-gas. This gas is rich in methane and other organics, and can be burned as a fuel for heating or for electric power generation. Solid residual from the digestion process can be used as a soil amendment. The process also separates recyclable materials such as glass and metals.

One of the anaerobic technologies, the ArrowBio Process from Haifa, Israel, is operating in a 300 TPD full-scale MSW demonstration process line in Tel Aviv, illustrated in Figure 12-11.[12]

[11] “Anaerobic Digestion Outlook for MSW Streams,” BioCycle, August 2007, Vol. 48, No. 8, p. 51.

[12] Source: ArrowBio, Haifa, Israel.

Figure 12-11 – ArrowBio Process Schematic



The system operates without high temperatures or pressure. In theory, it is extremely simple, relying on non-specialized mechanical equipment (pumps, screens, macerators, tanks, conveyors, etc.) for operation. Digestion occurs through the presence of natural microorganisms in MSW, and charging with specialty or unique bacteria is not necessary. It has a high resistance to upsets because of the scale of its operation, i.e., with hundreds of tons of MSW entering the system per day, any poisons that might threaten the digestion process (as has been experienced with sewage treatment plant digesters) are likely to be of such small fraction that it will have no significant effect on digester cultures.

The system is equipment and labor intensive. Although redundancy is normally built into the system, with multiple process lines and duplication of critical pumps, conveyors, etc., additional equipment adds to the number of separate process and associated equipment necessary for operation. To date, no operating facility processes more than a few hundred TPD. The Tel Aviv installation of Arrow has thus far experienced many shut-downs due to the presence of troublesome components in the input waste stream. To combat this, a higher level of pre-processing is being implemented for more reliable operations.

12.5.2.4 Mixed Waste Composting

Composting is a natural process that depends on the action of microscopic organisms to break down organic matter. Composting has been used for hundreds of years to process a variety of agricultural wastes. There are two types of micro-organisms that digest the organic materials: aerobic and anaerobic. The first need oxygen or air to function and the latter work without oxygen. Anaerobic composting produces combustible biogas as a byproduct. There are five factors that influence the composting process: (1) moisture, (2) oxygen or air, (3) temperature, (4) chemical balance of carbon and nitrogen and (5) particle size.

Large scale mixed waste composting facilities are industrial plants which receive waste and grind the material in large shredders, removing inert materials by screening and other processes. The feed material is then moved to the composting vessel where the organic materials are digested by the micro-organisms. The process and factors 1 through 3 are controlled by computer. After initial processing the resulting compost product is stored to “cure” and then it is ready to be sold. Using California post-recycling waste composition data[13], it is estimated that aerobic composting would reduce the waste landfilled to 25 percent of the initial feed. There would be 43 percent recovered as compost and material products and 32 percent released to the atmosphere as gases (mainly CO_2 and water vapor).

There are several hundred mixed waste composting plants in Europe, both aerobic and anaerobic. The trend seems to be toward segregating bio-wastes and then composting to produce biogas. In the United States, composting is used primarily to process yard waste and sewage sludge, and there are thousands of successful projects. BioCycle reports[14] that there are 14 mixed solid waste composting facilities operating in the United States in 2006. These are generally small units processing less than 120 TPD, with two facilities processing 200 to 250 TPD. Large-scale plants have been built in Portland, OR, Baltimore, MD, Miami, FL, Atlanta, GA, and Pembroke Pines, FL, all of which failed for technical reasons, generally odor control or financial difficulties. A key problem has been that the quality of the product produced was lower than expected, which reduced the revenues and made the projects too costly and/or non-competitive with other available alternatives.

12.5.2.5 Plasma Arc

Plasma arc gasification was developed in 19th Century Germany. NASA utilized it in the 1960s to simulate re-entry temperatures to test heat shields on spacecrafts. Dr. Lou Circeo, of Georgia Tech's Construction Research Center in Atlanta, began testing it on garbage in the 1970s.

The General Motors (GM) facility in Defiance, Ohio has been using a plasma arc gasification process developed by Westinghouse since 1989 to create high temperatures to recycle scrap metal. As of 1999, Hitachi Metals Ltd. has utilized a smaller version of the Westinghouse system to process 25 TPD of MSW at a plant in Yoshii. In 2002, the Japanese cities of Mihama and Mikata commissioned the building of a 28-TPD plasma arc gasification facility.

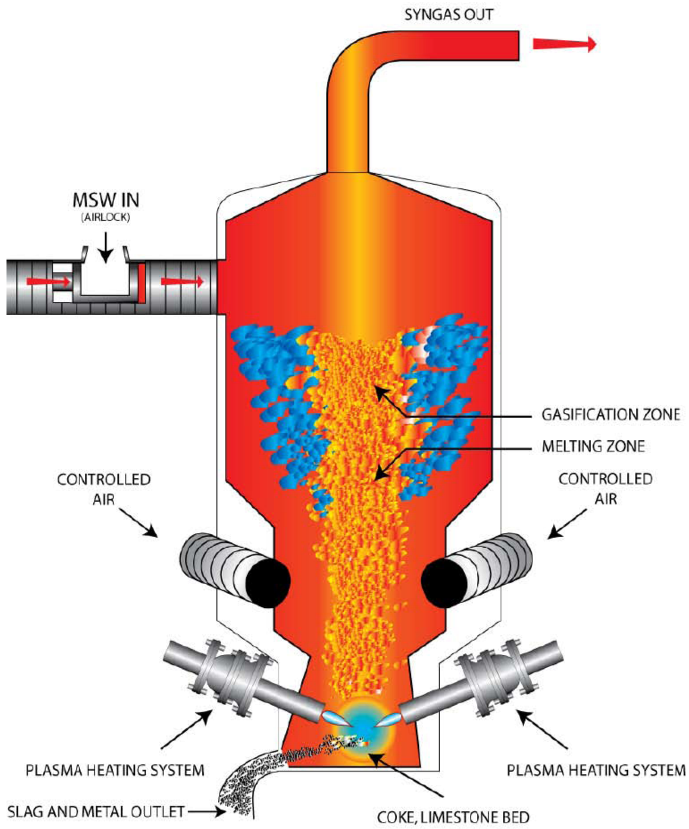
Plasma arc technology is the destruction of MSW using the intense heat generated by a plasma torch. It is a pyrolysis-related process where little or no oxygen is injected into a reactor. A typical unit is shown in Figure 12-12.

Electric current is passed though a series of torches at the bottom of a reactor, which heat a process gas (not shown) to a temperature in excess of 5,000°F. This hot gas stream heats waste within the reactor to over 3,500°F and, as air is provided to the system at a low controlled rate, some of the waste will burn to help

[13] Statewide Waste Characterization Study, California Integrated Waste Management Board, December 1999.

[14] BioCycle Magazine, JG Press, Inc., November 2006.

Figure 12-12 - Cross-Section of a Plasma Arc Furnace[15]



maintain reactor temperature. At this high temperature, organics within the waste will form elemental compounds such as hydrogen, oxygen and carbon and some of this carbon will convert to carbon monoxide or methane. The gas flow will have a high enough heat content to be able to sustain its own combustion and be used as a fuel gas external to the system.

The inorganic portion of the waste will form a liquid slag which eventually drops from the reactor into a water bath. As soon as it hits the water it will shatter into a glassy-looking residue. That may be suitable for fill or use as a construction material. The material, however, may need to be regulated by the State's Solid Waste Section.

There are no commercial-scale plasma arc systems firing MSW in the United States. There are pilot plants in Japan used for ash vitrification, and a smaller Japanese facility firing MSW, but attempts to apply this process in the United States have not been successful. The electric power requirements for the torch are significant, and maintenance of torches and reactor refractory materials is also a significant expense item.

Few, if any of the plasma arc pilot facilities have been able to generate a fuel gas (synthetic natural gas, or syngas), and air emissions have been found to be no better than conventional incineration systems. The firm Geoplasma, from Atlanta, is negotiating a contract for construction of a large plasma arc facility for MSW in St. Lucie County, Florida, which will also to be used for processing mined landfill waste.

[15] Geoplasma, Atlanta, GA

12.5.2.6 Chemical Decomposition

Chemical decomposition, also referred to as depolymerization, is a process whereby waste is directly liquefied into useful chemical feedstocks, oils and/or gases. The oils are a replacement for fuel oil and the gases consist of carbon monoxide, hydrogen and methane. The process generally utilizes medium temperature and pressure to break large complex molecules into smaller ones. If higher temperatures are employed, chemical decomposition becomes indistinguishable from gasification.

The solid waste feedstock for chemical decomposition will generally be pre-processed to remove recyclable and inert materials and to reduce the particle size. Moisture is favorable to the process and may need to be added to create steam reforming reactions. The process is multi step: gas recovery, liquid separation to isolate the oil product, and processing the solids to separate carbon char from inerts. Chemical decomposition processes require an external energy source to make the reactions take place.

Changing World Technologies (CWT) offers a chemical decomposition process that they indicate can be applied to mixed solid waste. Currently, they have a plant operating on poultry waste in Carthage, MO, which was commissioned in 2005. CWT was selected for further consideration by the City of Los Angeles.

One form of chemical decomposition is used to break cellulose into sugars for fermenting to produce ethanol. This is the hydrolysis process, of which two types have been applied to the organic components of solid waste: acid hydrolysis and enzyme hydrolysis. They have also been used in combination. The National Renewable Energy Laboratory developed and has operated pilot processes which have demonstrated to be technically feasible. No production plants, however, have been built to date. The City of Los Angeles received nine submissions for hydrolysis processes, including those from Arkenol and Iogen, a DOE demonstration and commercialization project contractor. No hydrolysis process was selected by the City of Los Angeles.

Microwaves can be used as the external heat source for chemical decomposition or depolymerization. Microwave systems have been built to decompose some special wastes, particularly tires. Goodyear obtained a patent to “de-vulcanize” tires and built a facility to process in-plant scrap in the late 1970s. Several small units have been operated on tires. The application of microwaves to drying and decomposition of various wastes, including medical waste and nuclear waste, is proven, but its application to municipal solid waste has not been proven but is being promoted by Molecular Waste Technologies, Inc. Global Resource Corporation also proposes microwave plants for MSW, but has not constructed one.

12.5.3 Recent Procurements for Alternative Resource Conversion Technologies

Over the past four to six years, several local government and/or regional authority groups have conducted studies and requested information, and initiated procurements for considering alternative resource conversion technologies to be added to their integrated waste management systems. Table 12-3 provides a listing of the locations and the various vendors that have responded to these initiatives. Reviews of those efforts conducted by the City of Los Angeles and Los Angeles County are specifically highlighted, as requested by SWRAC.

Table 12-3 - Alternative Resource Conversion Technologies Vendor List

Technology	Jurisdiction / Vendors	New York City	City of Los Angeles - Phase I	City of Los Angeles - Phase II	Los Angeles County - Phase I	Los Angeles County - Phase II	Frederick/Carroll County, MD	Harford County, MD	City of Sacramento, CA	Broward County, FL	St. Lucie County, FL	Pinellas County, FL	Total Times Evaluated/Proposed
Advanced Thermal Recycling	Global Environmental Technologies	X											1
Advanced Thermal Recycling	Consutech Systems LLC		X										1
Advanced Thermal Recycling	Basic Envirotech Inc.		X										1
Aerobic composting	Wright Environmental Management Inc. (Wright)		X		X								2
Aerobic composting	American Bio-Tech		X										1
Aerobic composting	Horstmann Recyclingtechnik GmbH		X										1
Aerobic Digestion	Mining Organics	X											1
Aerobic Digestion	Real Earth Technologies	X											1
Aerobic Digestion	American Bio-Tech				X								1
Aerobic Digestion	HotRot Exports Ltd, or Outspoken Industries				X								1
Aerobic Digestion	International Bio Recovery Corporation (IBR)				X								1
Anaerobic Digestion	Arrow Ecology and Engineering	X			X	X							3
Anaerobic Digestion	Canada Composting	X			X								2
Anaerobic Digestion	Kame/DePlano	X											1
Anaerobic Digestion	New bio	X											1
Anaerobic Digestion	Orgaworld	X											1
Anaerobic Digestion	Organic Waste Systems	X			X								2
Anaerobic Digestion	VAGRON	X											1
Anaerobic Digestion	Valorga S.A.S. (Valorga)/Waste Recovery Systems	X	X		X					X[1]			4
Anaerobic digestion	Canada Composting, Inc. (CCI)		X										1
Anaerobic digestion	Organic Waste Systems N.V. (OWS)		X										1
Anaerobic digestion	ISKA GmbH		X										1
Anaerobic digestion	Arrow Ecology Ltd. (Arrow)		X										1
Anaerobic digestion	Citec		X										1
Anaerobic digestion	Global Renewables/ISKA		X		X								2
Anaerobic Digestion	Waste Recovery Seattle, Inc. (WRSI)		X	X					X	X			4
Anaerobic Digestion	Urbaser			X[1]					X	X[1]			3
Composting	Zanker								X				1
Composting	RRI - Switzerland								X				1
Gasification	BRI Energy	X			X								2
Gasification	Dynecology	X											1
Gasification	Ebara	X	X		X								3
Gasification	Ecosystem Projects	X											1
Gasification	Emerald Power/Isabella City	X											1
Gasification	GEM America	X											1
Gasification	ILS Partners/Pyromex	X											1
Gasification	Interstate Waste Technologies/Thermoselect (IWT)	X	X	X	X	X				X			6
Gasification	Jov Theodore Somesfalean	X											1
Gasification	Kame/DePlano	X											1
Gasification	Taylor Recycling Facility	X	X		X								3
Gasification	Thermogenics	X											1
Gasification	Primenergy (RRA)		X		X								2
Gasification	Omnifuel /Downstream Systems (Omni)		X										1
Gasification	Whitten Group /Entech Renewable Energy System		X		X	X							3
Gasification	Energy Products of Idaho (EPI)		X										1
Gasification	Brightstar Environmental		X										1
Gasification	Omnifuel Technologies, Inc.				X								1
Gasification	Green Energy Corp				X								1
Gasification	Envirepel								X				1
Gasification	Zia Metallurgical Processes, Inc.			X									1
Hydrolysis	Arkenal Fuels	X											1
Hydrolysis	Biofine	X											1
Hydrolysis	Masada Oxynol	X											1
Mass Burn	Covanta Energy Corporation		X	X			X	X	X	X		X	7
Mass Burn	Wheelabrator Technologies Inc.			X			X	X		X		X	5
Mass Burn	Veolia Environmental Services											X	1
Mass Burn	Seghers Keppel Technology, Inc. (Seghers)		X	X[1]									2
Other Thermal (Microwave)	Molecular Waste Technologies, Inc.				X								1
Plasma Gasification	Global Energy Solutions	X			X					X			3
Plasma Gasification	GSB Technologies	X											1
Plasma Gasification	Peat International/Menlo Int.	X											1
Plasma Gasification	Rigel Resource Recovery and Conversion Company	X			X								2
Plasma Gasification	Solena Group	X											1
Plasma Gasification	Startech Environmental	X											1
Plasma Gasification	Geoplasma LLC				X						X		2
Plasma Gasification	Plasma Environmental Technologies, Inc.				X								1
Plasma Gasification	Plasco Energy Group			X									1
Plasma Gasification	USST								X				1
Pyrolysis	Entropic Technologies Corporation	X											1
Pyrolysis	Pan American Resources	X	X		X								3
Pyrolysis	WasteGen Ltd. /TechTrade (WasteGen)		X		X								2
Pyrolysis	Conrad Industries				X								1
Pyrolysis	Graveson Energy Management				X								1
Pyrolysis	International Environmental Solution				X	X			X				3
Steam Classification	BLT/World Waste Technologies								X				1
Thermal Depolymerization	Changing World Technologies	X			X	X							3
Thermal Oxidation	Zeros Technology Holding	X											1

12.6 Environmental Ramifications

Solid waste incinerators, which EPA refers to as Municipal Waste Combustors, are regulated under the federal Clean Air Act (CAA), originally passed by Congress in 1963 and updated in 1967, 1970, 1977, and 1990. EPA has promulgated a number of regulations under the CAA since 1990. Numerous state and local governments have enacted similar legislation, either implementing federal programs or filling in local gaps in federal programs.

Section 111 of the federal Clean Air Act directs EPA to establish pollution control requirements for certain industrial activities which emit significant "criteria air pollutants." These requirements are known as new source performance standards (NSPS) and regulate pollutants. For thermal destruction of solid waste, the NSPS control particulate matter (PM), sulfur dioxide(SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), hydrogen chloride (HCl), dioxins/furans, cadmium, lead, mercury, fugitive ash and opacity. NSPS are detailed in Chapter 40 of the Code of Federal Regulations, Part 60 (40 CFR Part 60), and are intended primarily to establish minimum nationwide requirements for new facilities.

Section 112 of the pre-1990 federal Clean Air Act directed EPA to establish standards to reduce emissions of hazardous air pollutants (HAPs). These pollutants include asbestos, benzene, beryllium, inorganic arsenic, mercury, radionuclides, and vinyl chloride. National emission standards for hazardous air pollutants (NESHAPs) are detailed in 40 CFR Part 61 and establish minimum nationwide requirements for existing and new facilities.

The post-1990 NESHAPs require the maximum achievable control technology (MACT) for a particular industrial source category, and are often referred to as "MACT standards." The pre-1990 Clean Air Act prescribed a risk-based chemical-by-chemical approach. The 1990 Clean Air Act Amendments outlined a new approach with two main components. The first component involves establishing technology-based source category standards, and the second component involves addressing any significant remaining risk after the national standards are in place. The NESHAPs promulgated under the 1990 Clean Air Act Amendments can be found in 40 CFR Part 63 and establish nationwide requirements for existing and new facilities.

EPA may implement and enforce the requirements or EPA may delegate such authority to state or local regulatory agencies. Sections 111 and 112 of CAA allow EPA to transfer primary implementation and enforcement authority for most of the federal standards to state, local, or tribal regulatory agencies. In general, EPA does not delegate to state or local agencies the authority to make decisions that are likely to be nationally significant, or alter the stringency of the underlying standard.

The Section 111 and 112 emissions limits applicable to new Municipal Waste Combustors are:

Dioxin/furan (CDD/CDF)	13 nanograms per dry standard cubic meter
Cadmium (Cd)	10 micrograms per dry standard cubic meter
Lead (Pb)	140 micrograms per dry standard cubic meter

Mercury (Hg)	50 micrograms per dry standard cubic meter
Particulate Matter (PM)	20 milligrams per dry standard cubic meter
Hydrogen chloride (HCl)	25 PPM or 95 percent reduction
Sulfur dioxide (SO_2)	30 ppm or 80 percent reduction
Nitrogen Oxides (NO_x)	180 ppm dry volume, and 150 ppm dry volume after first year of operation

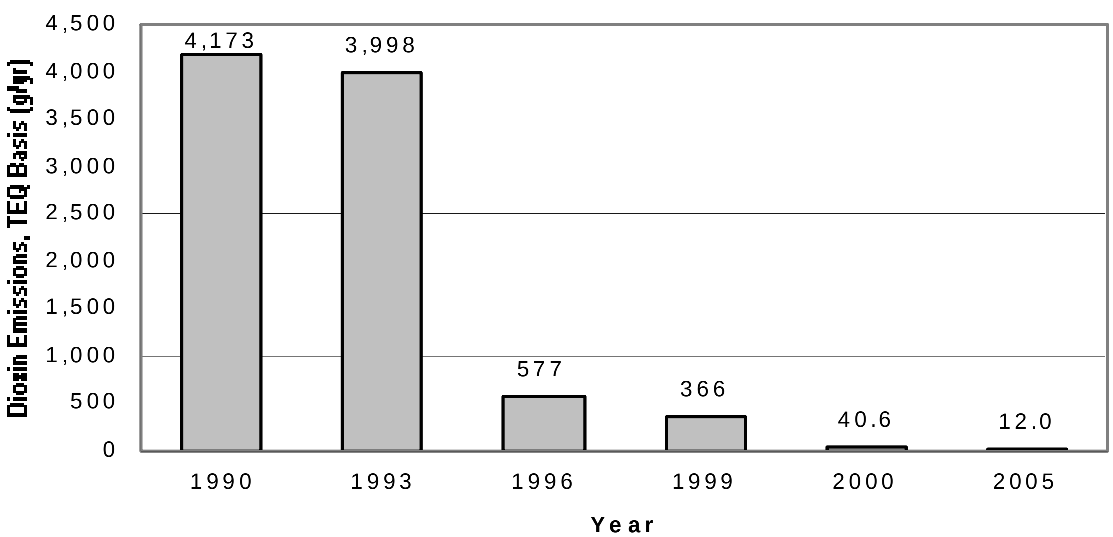
A new source review (NSR) permit is required for a new municipal waste combustor and, in addition, depending on its size and emission quantities, it must meet the prevention of significant deterioration (PSD) permit requirements. The PSD permit conditions require an analysis of existing (ambient) air quality in the area surrounding the proposed facility.

12.6.1 Air Quality Impacts

In the early 1980s, dioxins were discovered in the exhaust of a WTE facility on Long Island, NY. This chemical, toxic to animals in even very small quantities, was a major concern. Other WTE plants were tested, as well as other types of facilities, and were found to be a major dioxin source. In 1995, amendments to the CAA were enacted to control the emissions of dioxins, as well as other toxins, such as mercury, hydrogen chloride, and particulate matter.

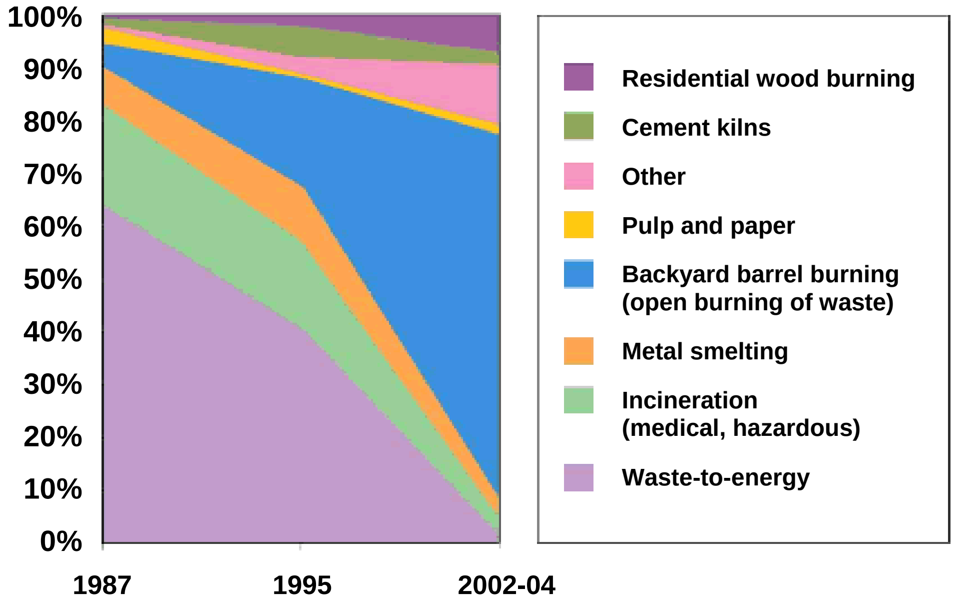
With the implementation of the CAA requirements in the following years, dioxin emissions from WTE decreased significantly, as shown in the chart in Figure 12-13 (From: Emissions from Large MWC Units at MACT Compliance, Docket A-90-45 (Large MWCs), U.S. EPA, Research Triangle Park, NC).

Figure 12-13 – Dioxin Emissions, TEQ Basis



While WTE plants had been a major source of dioxins in 1987 as shown in the chart in Figure 12-14, it has not been considered a significant dioxin source since 2002. EPA has stated that "Waste-to-Energy is no longer a major contributor of dioxin emissions." (see USEPA Docket A-9045, VIII.B.11, Office of Air Quality and Standards, 2002)

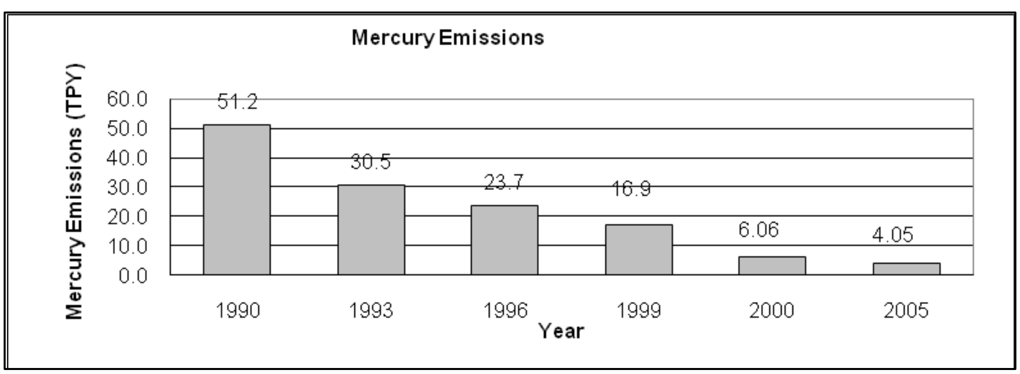
Figure 12-14 – Changes in Dioxin Sources



Mercury is another toxin that was found in WTE exhaust and was addressed in the CAA amendments. By modifications in the burning process and the use of activated carbon injection in the air pollution control system, dioxins and mercury, as well as hydrocarbons and other constituents, have effectively been removed from the gas stream.

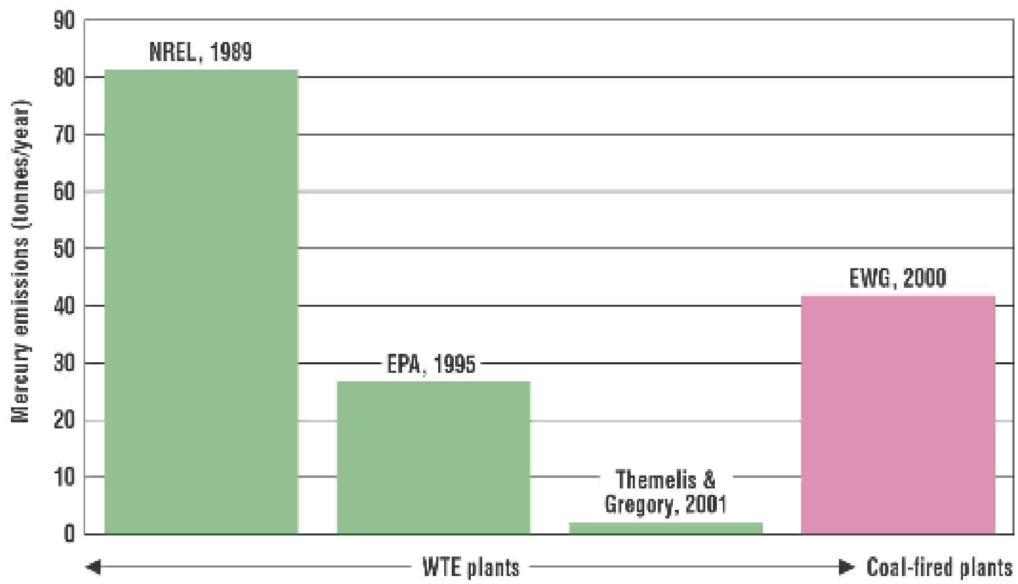
Mercury emissions from WTE have been reduced from 1990 levels, as shown in the chart in Figure 12-15 (From: Emissions from Large MWC Units at MACT Compliance, Docket A-90-45 (Large MWCs), U.S. EPA, Research Triangle Park, NC). This chart shows a 91.2 percent reduction in 2005 from 1990 levels.

Figure 12-15 – WTE Mercury Emissions



Overall emissions of mercury in the United States from both WTE and fossil fuel-fired electric power plants are shown in the chart in Figure 12-16 (From: Mercury Emissions from High Temperature Sources, N. Themelis, A. Gregory, ASME Solid Wastes Processing Division Proceedings, May 2002, and the Environmental Working Group, http://www.ewg.org).

Figure 12-16 – Mercury Emissions from WTE and Coal-fired Plants



Whether reviewing dioxin data or mercury emissions, it is clear that WTE facilities have made a concerted effort to reduce these emissions to insignificance. These two pollutants have been identified by the public as the surrogate for all WTE emissions, but other emissions have decreased correspondingly as well, such as carbon monoxide, hydrogen chloride, nitrogen oxides and particulate matter (soot).

12.6.2 Greenhouse Gases

The “greenhouse” effect results from sunlight striking the Earth’s surface and, when it gets reflected back towards space as infrared radiation (heat), it gets absorbed by gases trapping the heat in the atmosphere. Many chemicals that are present in the Earth’s atmosphere act as “greenhouse gases (GHG).” These gases allow sunlight to enter the atmosphere freely, but prevent transmission of the reflected sunlight back to space. Many gases exhibit these “greenhouse” properties. Some of them occur in nature (water vapor, carbon dioxide, methane, and nitrous oxide), while others are exclusively human-made, such as chlorofluorocarbon compounds.

Prior to large scale industrialization the level of greenhouse gases in the atmosphere had remained reasonably constant for a long period. Since industrialization, however, the levels of several important greenhouse gases have increased by 25 percent. Carbon dioxide (CO_2) is a key green house gas. During the past 20 years, about three-quarters of human-made carbon dioxide emissions were from burning fossil fuels.

The greenhouse gases that are generated in solid waste processing and disposal that are of concern are: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (NO_2).

Each of these gases can be divided into two categories, based on the source of the materials in the waste: (1) biogenic sources and (2) fossil sources.

In 2007, a King County, Washington study[16] compared the GHG for five technology options:

1. Mass-burn, waterwall facilities;
2. RDF with dedicated boiler;
3. Advanced thermal recycling (gasification/pyrolysis);
4. Landfilling with landfill gas capture and flaring; and
5. Landfilling with landfill gas combustion, using internal combustion engine.

The study examined the direct emissions from each process and fugitive emissions[17] but did not include the emissions associated with transportation of waste to the disposal facility.[18] The emission values in the King County report also included those that are avoided by replacing existing electricity generation emissions. The result of the King County study is that the GHG emissions from any of the conversion approaches are double that of landfilling with landfill gas utilization (Option 5), including landfilling without gas utilization (Option4).

In the case of King County, the electricity replaced is generated by hydro and natural gas. Further, the State of Washington does not recognize either all or part of refuse as a renewable fuel.

12.6.3 Water

Mass-burn and RDF incineration technologies require a water supply and all types of projects have a wastewater discharge. Besides domestic water for workers, potable water is required for the waste heat boilers.

Non-potable water may be used as cooling water for the steam condensers, but the large cooling water supplies necessary for condenser cooling are normally not available, and cooling towers or cooling water ponds are provided as part of the facility.

If a steam customer is the energy market, the water requirement may be increased significantly from that needed for electricity generation, assuming that the customer generally does not return condensate. Some projects may cogenerate steam and electricity for sale, such as district heating/cooling projects or those with a significant steam user in proximity of the WTE facility site.

Gasification and anaerobic digestion technologies will not necessarily use a boiler. They may generate a gas stream for use off-site and not require a condenser cooling water system.

[16] Comparative Evaluation of Waste Export and Conversion Technologies Disposal Options, King County, Department of Natural Resources and Parks, Solid Waste Division, June 2007 (Draft).

[17] Landfill gas capture in all landfills is never total. R. W. Beck, the author of the report, estimated an 80 percent capture and 20 percent fugitive emissions.

12.6.4 Residue Disposal

Another consideration is ash disposal. For all but the high-temperature thermal options and the anaerobic digestion system, an ash will be generated. Bottom ash will be discharged from the bottom of the furnace chamber, and fly ash will be collected by the air pollution control system.

Generally, the bottom ash will not be classified as a hazardous material, subject to ash testing and analysis. Fly ash, however, will have a higher concentration of heavy metals, and may also contain residual organics. As such, it would likely be classified as a hazardous material if it fails toxicity testing, unless it is combined with bottom ash, as is the current U.S. practice.

The fly ash can be treated with a fixative to prevent the leaching of hazardous constituents, so as to be classified as a non-hazardous material. There are a number of fixatives, which have achieved the regulatory requirements. The cost of a fixative must be compared to the options for ash disposal to determine the cost-effective solution for the ash. Part of this analysis would be determining if a market exists for the bottom ash, or for ash that has been treated with a fixative.

The solids residual from high temperature systems, such as plasma-arc or pyrolysis, may have a better opportunity for end-use applications and marketing. These glassy-type granules may be classified as non-hazardous and used in construction materials, or as a fill.

The residue from anaerobic digestion is nothing more than stones, glass or similar items, which is normally directed to a solid waste landfill.[19]

12.6.4.1 WTE and Ash

All incineration produces ash. WTE facilities produce two kinds of ash. The first residue coming off the grates in the boiler or fire box is referred to as bottom ash. Second, the solid particulate material removed from the combustion gases is referred to as fly ash. Bottom ash and fly ash contain heavy metals such as lead, cadmium, copper, and zinc, but in different concentrations. The two ash fractions can be combined or removed from the facility separately. All ash residue - bottom ash, fly ash or combined ash - must be tested, using the Toxicity Characteristics Leaching Procedure (TCLP), to determine if the levels of heavy metals render it hazardous under RCRA regulations. In addition, DOH requirements to minimize health and environmental risks for ash recycling would be addressed in the facility permit. This permit would be applied for during the implementation of the WasteTEC facility. DOH requirements could be a project-specific review similar to that required for the H-Power facility on Oahu. However, the vast majority of ash - bottom ash, fly ash or combined ash – disposed over the last 20 years from WTE facilities in the U.S. has tested nonhazardous. The combined ash amounts to 15 to 20 percent by weight and 4 to 10 percent by volume of the original quantity of waste going into a WTE facility.

The SWRAC research tour made a site visit to an ash monofill in Marion County, Oregon in July 2007. The monofill is only used for ash so there is no organic material to decay and so no methane is produced.

There have been processes applied to the Fly Ash so that it can be safe to use in certain types of construction. One example of such a process is the WES-PHix. This is a proprietary process that adds phosphoric acid to the fly ash to promote the

[19] "Evaluation of Emissions from Burning of Household Waste in Barrels," USEPA, November 1997.

formation of lead phosphate in order to limit the solubility of lead in the ash. Generally, the ash is transported from the WTE to a facility where then it is mined by being scooped up, placed on, and run through a series of conveyers, screens, and vibrating panels. The finds, material pulled out of the ash, are valuable in that they are metal, which is sold to scrap dealers, and coins which are sold back to the U.S. Mint. The remainder is ash that is sprayed with the WES-PHix process of Wheelabrator Technologies Inc. that, essentially, binds the material so that it will not leach the heavy metals.

Processes, such as the WES-PHix, create a product that is a substitute for gravel and can be used as a sub-base for the construction of roads or use in construction blocks, artificial reefs, and shoreline erosion control. States, however, are cautious about allowing this material used as a substitute for virgin material. State regulations demand that such material pass the TCLP requirements.

TCLP tests on ash were conducted over nine years at the Honolulu WTE facility known as H-Power. Two noticeable findings occurred. First, arsenic, cadmium, chromium, mercury, lead, selenium, and silver tested below the EPA limits and therefore were not considered hazardous. Barium, however, did not meet the TCLP requirements. Second, all the constituents, except for barium, saw concentrations go down over time. H-Power had done little removal of items, other than ferrous metals, from the waste stream that may account for this downward trajectory.[20] Should the County implement a WasteTEC facility or any other concentration process for refuse, the concentrations of metals will probably be lower than Honolulu because of Maui's small industrial sector.

Although ash generated from WTE in the U.S. is generally buried in a monofill, countries that have used WTE as a significant waste management tool are utilizing more of the ash for beneficial use. Germany uses 50 percent of the bottom ash in road bases and sound barriers on its autobahns. The Netherlands has a goal of using 80 percent of WTE residues. Currently, it uses 40 percent of the fly ash in its asphalt. Denmark began using its bottom ash in a beneficial way in 1974 in such things as sub-base for parking lots, bicycle paths, and paved roads.[21]

Binding processes, such as WES-PHix, are not solely used to develop products. If managers of WTE facilities can process fly ash so that it is not considered a hazardous material then it, like the bottom ash, can be placed into a Subtitle D, part 258, municipal solid waste landfill. This lowers the cost of disposal considerably.

One of the longest studies of leachate generation at an ash monofill was conducted at the ash monofill in Marion County, Oregon, where the Maui SWRAC members made a site visit to this facility. The EPA selected the site in 1986 to evaluate the amount and character of the leachate, the aging of the ash, and of the surrounding soils.

Table 12-4[22] shows the results of these tests. The first section reviews the findings from Cell 1, which was used as an interim ash fill and was only partially closed in 1990

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[20] Wiles, Carlton & Phillip Shepherd.

[21] "Municipal Solid Wastes: Problems and Solutions," by Robert E. Landreth & Paul A Rebers: 185; also see EPA PowerPoint On uses of ash in other countries: http://www.epa.gov/region2/cepd/pdf/6frankroethelspresentation.pdf.

[22] Roffman, H.K. & Jeff Bickford, "Effects of Municipal Waste Combustion Ash Monofills Longterm Monitoring." Proceedings, Tenth International Specialty Conference on Municipal Solid Waste Combustor Ash Utilization, Arlington, VA, June 21-23, 1997; also summarized in H. Lanier Hickman Jr., American Alchemy: The History of Solid Waste Management in the United States, Forester Press, 2002, pp. 320-321.

but finally closed in 1997, and the second section contains the findings from Cell 2 which was opened in 1990.

Table 12-4 – Marion County WTE Leachate Tests

Cell 1: Constituent	1988 (5)	1989 (2)	1990 (5)	1991 (4)	1992 (1)	1993 (2)	1996 (4)	1997 (1)
Al	NA	810	ND	225	100	ND	ND	ND
Arsenic	218	53	1,044	1	ND	ND	ND	ND
Barium	NA	ND	ND	797	630	570	450	360
Cadmium	0.6	1.4	ND	1.8	2.5	8.6	16.5	ND
Chromium	19	ND	ND	2.5	6	2.5	ND	ND
Cu	ND	ND	ND	18	70	20	48	ND
Lead	31	13	ND	ND	79	ND	6	ND
Mercury	ND	ND	ND	ND	ND	ND	0.3	ND
Zn	200	250	2	20	510	30	215	ND

Cell 2: Constituent	1992 (1)	1993 (3)	1994 (5)	1995 (1)	1996 (4)	1997 (1)
Al	2,000	ND	680	350	ND	ND
Arsenic	ND	8	ND	ND	ND	ND
Barium	2,300	3,010	991	1,800	1,075	5,620
Cadmium	92	465	215	261	73	ND
Chromium	60	0.7	ND	ND	ND	ND
Cu	140	410	99	140	42	ND
Lead	41	63	20	100	5	ND
Mercury	ND	1	0.6	ND	0.2	ND
Zn	420	833	219	300	330	1,900

The numbers enclosed in parentheses (#) show the number of tests performed that specified year. "ND" stands for "not detected" while "NA" represents "not analyzed."

The results of these tests are as follows:

- Metal concentrate in the leachates were all below EP-Toxicity and TCLP maximum allowable levels;
- Dioxin levels in all soil samples were below the 1-ppb recommended levels for residential soils;
- Metal contents of the soils were within regional and national levels;
- Concentration of metals in the soils near the monofill did not exceed those found in the background samples;
- Major constituents in the leachates were dissolved salts, primarily of chloride, sulfate, cadmium, potassium, and sodium.

When the ash is removed from the WTE facility, the scrubber residue from the air pollution control devices is also taken to the ash monofill with the ash. This residue is primarily gypsum (unreacted lime, calcium oxide, and calcium sulfate) that, once compacted with the ash in the monofill, will further react and immobilize heavy metals. When compacted, gypsum creates a near impermeable surface as SWRAC members experienced when walking atop Marion County's closed cell of ash.

The studies on ash and the placement of ash in monofills have led to a general consensus among solid waste professionals that "…landfilling ash is really a no-brainer and its potential impact on the environment is essentially nonexistent."[23]

12.6.4.2 Recycling and WTE

Recycling and WTE have been considered at the opposite ends of the spectrum by many. EPA does not consider WTE a recycling process notwithstanding it transforms MSW into a beneficial energy product. The ash can be processed to recover metals and even coins and jewelry that otherwise would rest in landfills. Yet, a perception remains in the U.S. that WTE facilities slow rather than advance recycling activities.

In 2002, a survey of U.S. WTE facilities by the Integrated Waste Services Association took a look at the effect WTE facilities have had on local recycling efforts. "According to the U.S. Environmental Protection Agency," write the authors of this study, "the current municipal recycling rate in the U.S. is 28%. By comparison, 57% of the 98 WTE communities contacted for this investigation have a higher recycling rate. Further, the average recycling rate for all U.S. WTE communities is 33%. Ten years ago, WTE communities had an average recycling rate of 21% versus the national rate of 17%."[24] Simply stated, the balance among recycling and WTE is a matter of local choice, policy decisions, and program decisions. There does not have to be a perceived conflict; they can be implemented to coexist and support an overall goal of minimizing what ends up in a landfill and not wasted for some other beneficial use. Local public policy, programs, and practices need to be put in place which allocate how MSW is managed.

12.6.4.3 WTE and Maui County

Field research was conducted to see if the County would benefit from implementing a WTE process. One half of the evaluation was on the advantages and disadvantages of generating electricity which will be reviewed in this chapter. The second half of the investigation looked at developing significant recycling operations in conjunction with a WTE strategy.

The County's waste stream, both current and projected out to the year 2030, could sustain a WTE facility and a 54 percent recycling rate. Table 12-5 projects out the population in five-year increments, using 2005 as the base year, the MSW stream, the amount recycled and MSW available to go into a WTE facility. The table projects achieving the 54 percent recycling rate in 2010. The results were that the WTE facility with a rated capacity of 575 TPD at 90 percent availability would produce 144 TPD of ash and 14 megawatts of electricity.

[23] H. Lanier Hickman Jr., American Alchemy, 2002: pg. 321. Mr. Hickman was the executive director of the Solid Waste Association of North America for 20 years and, before that, the director of operations for the Office of Solid Waste, USEPA.

[24] "Recycling and Waste-to-Energy: The ongoing compatibility success story," MSW Management Magazine, May/June 2003.

Table 12-5 – Current and Projected Waste Stream

	2005	2010	2015	2020	2025	2030
MSW Generated	339,241	366,921	389,219	414,617	441,128	467,864
Materials Recycled	122,313	197,599	207,576	218,880	230,669	242,386
MSW Disposed	216,928	169,322	181,644	195,737	210,459	225,478

12.7 Economic Characteristics of Waste Processing Technologies

The economic characteristics of a WTE facility include capital and operating costs and revenues. Table 12-6 provides an estimate of expected cost figures and associated performance data. Note that the costs are mainland U.S. costs and not adjusted for Maui.

A significant factor in the net operating costs is revenue from the sale of recovered energy and recyclables. The energy revenue is a function of negotiations between the facility operator and the energy markets, typically a utility, and may include, besides a power rate, revenue for capacity and a requirement for standby power. Capital equipment necessary for utility connections can also be part of the negotiations, and the listed figures are estimates that have to be developed and refined for specific sites and requirements during a procurement/development and negotiation process.

Table 12-6 - Facility Cost* and Performance Factor Estimates

Cost/Performance Parameter	Modular WTE (100 to 400 TPD)	Mass-burn WTE (200 to 750 TPD)
1. $ Capital Per Installed Ton	$120,000 to $150,000	$200,000 to $275,000
2. O&M Cost, not including ash disposal costs	$50 to 60 per ton	$45 to 50 per ton
3. Availability (net of scheduled and unscheduled downtime)	80-90%	90-95%
4. Steam production; assumes 5,200 BTU per LB waste feedstock	5,000 pounds per ton MSW input	6,000 pounds per ton MSW input
5. Electricity production; assumes no steam extracted and sold	➢ 350 kWh per ton net of in plant usage ➢ 0.012 to 0.016 MW per ton sold of daily capacity	➢ 470-550 kWh per ton net of in plant usage ➢ 0.02 to 0.027 MW per ton sold of daily capacity
6. Energy Revenue Sharing	10 percent typically; sometimes more for generation above guaranteed amounts	
7. Metals removal, primarily ferrous; assumes mixed MSW	2-5%, primarily ferrous	
8. Materials Revenue Sharing	50 to 80 percent; less value here so more given away	
9. Ash generation	30 to 35 percent by weight; 10 -15% by volume	25 to 32 percent by weight; 10 percent by volume
10. Ash Disposal Costs	$15 to 60 per ton; lower if landfill self-owned; higher if market facility used	

*Mainland numbers.

Source: GBB, September 2007; $ shown are costs estimated for U. S. mainland – costs here not adjusted for Maui.

12.8 Energy Market in County of Maui

12.8.1 Cost of Energy

The cost of energy in Hawaii and on Maui is generally related to Number 2 fuel oil costs. Fuel costs for electricity in Hawaii and on Maui are the highest in the United States. These costs will continue to rise as the world price of oil increases. Maui Electric (MECO) uses this fuel in its two diesel engine generator facilities on the Island of Maui which cost, in 2007, about $2.85 per gallon without road use taxes. The average retail cost of electricity in Hawaii in 2006 was $0.2072 per KWh. However, a WTE facility would not sell power at the retail rate unless it had a dedicated customer. Generally, electricity sales contracts to utilities like MECO are priced at the avoided cost rate, which for MECO is between $0.07 and $0.09 per KWh. Since WTE should be considered firm power, it is reasonable to expect MECO to also include in its purchase price a component to value capacity. In so doing, the value of electricity from a firm renewable source should increase to, perhaps, $0.15 per KWh.

12.8.2 Long-term Plan of Power Company

MECO has filed the required Hawaii Public Utilities Commission report that addresses its long-term plan to meet future energy needs. The state renewable portfolio standards require that 10 percent of the energy generation be renewable by 2010 and 15 percent by 2015. MECO will meet these by the addition of 10 MW of wind power in 2011. MECO is also investigating the addition of more distributed generation and conventional generating units between 2009 and 2026. The plan includes the possibility of a waste-to-energy or biomass facility. In discussions with MECO, they were receptive to purchasing electricity from a WTE facility as well.

12.9 Plan Recommendation for Feasibility Study

12.9.1 SWRAC Recommendation

The SWRAC voted unanimously for the County to pursue the feasibility of commercial technology alternative resource management. This recommendation is specifically for the advancement of a Maui County feasibility study utilizing established data and best practices.

The intent of this advice was for the County to review the alternative technologies by using the research that others, including Los Angeles County and City of Los Angeles, have recently amassed to save the County time and money. The County and its contractor should digest this new research and then do a feasibility study projecting County costs and revenue.

12.9.2 Feasibility Study

The feasibility study would:

1. Review viability of alternative conversion technologies using, at a minimum, the recent Los Angeles studies discussed below. The purpose is to consolidate new evaluations into a matrix of cost, viability for Maui, and review the environmental and economic risks/benefits.

2. Review market feasibility for WTE and any process acceptable to Maui from the developed matrix in item 1.
3. Develop a design/permit/build/operate timeline and cost estimate on the process chosen by County of Maui.
4. Provide an environmental impact study of the chosen process.
5. Provide an Energy Balance review of the chosen facility.

When performing a feasibility study for such a significant infrastructure development, the scope of work should include certain project development building blocks for the project to be advanced toward procurement, contractor selection, permitting, design/construction/start-up/acceptance testing and eventual commercial operations. These building blocks are summarized as follows:

- Limited and high alternative disposal costs
- Waste supply assured recognizing selected reduce/reuse/recycling/diversion goals and expected growth looking forward for at least 20 to 30 years
- Energy market(s) interested and ready to advance contract with known terms, conditions and pricing
- Assessment of energy savings gained by installation and use of WTE plant
- Estimation of amount of energy to be produced by WTE, kilowatts per year, percentage of Maui County needs, amount saved in oil consumption.
- Site for facility with good logistics for waste receipt, energy market(s), and residue disposal; site needs to be able to be permitted and be acceptable to neighbors
- Landfill for ash and by-pass secured and costs for same understood for at least 20-30 years forward
- Experienced contractor to advance proven technology and facility concept through project development, permit, design, construction, start-up, acceptance testing and long-term operations under fixed priced and performance-based long-term service agreements
- Capital to finance the cost for the development and implementation process; public ownership preference so asset remains in the public control and flow control assured
- Financability so that a high rating is received for the bonds and low interest rate achieved; establish assured revenues for paying for costs of the project net of revenues from the sale of energy and materials recovered from the ash residues
- Compatibility with a high level of recycling so that overall program in compliance with State law and local desires for diversion; recycling and reduction can be programmed to address waste stream growth looking forward as well
- Public support to accept adding this to the infrastructure
- Political will to carry out this major infrastructure improvement for the long-term sustainability of having this element as part of the County's integrated solid waste management system

12.9.2.1 City of Los Angeles and Los Angeles County Studies

SWRAC advised the County to not "re-invent the wheel" when doing the feasibility study on alternative disposal systems. It, SWRAC, advised the County to cull from a recent and exhaustive study performed by Los Angeles City and County to find out the standards and viability of the "unproven" technologies for transforming MSW.

12.9.2.1.1 City of Los Angeles

Phase I[25]

In 2004, the City of Los Angeles Bureau of Sanitation (Bureau) began a study to evaluate MSW alternative treatment technologies capable of processing Black Bin material (curbside-collected residential MSW) to significantly reduce the amount of such material going to landfills. The Bureau's overall objective was to select one or more suppliers to develop a facility using proven and commercialized technology to process the Black Bin material and produce usable by-products such as electricity, green fuel, and/or chemicals.

The first step of this project was to develop a comprehensive list of potential technologies and suppliers. About 225 suppliers were screened, and 26 suppliers were selected to submit their detailed qualifications to the City. In order to screen the technology suppliers, they were sent a brief survey based upon the technology screening criteria. The criteria applied were as follows:

- Waste Treatability: The supplier was screened on whether they have MSW or similar feedstock processing experience.
- Conversion Performance: The supplier was asked if their facility would produce marketable byproducts.
- Throughput Requirement: This criterion was already met because the technology passed the technology screen.
- Commercial Status: This criterion was already met because the technology passed the technology screen.
- Technology Capability: The supplier was asked if their technology had processed at least 25 tons/day of feedstock.

Of the 26 suppliers requested to submit qualifications, 17 provided responses. These suppliers and their technologies were thoroughly evaluated and an evaluation report was published in September 2005 with the findings and ranking of the 26 suppliers' technologies that had met the criteria.

A Request for Qualifications (RFQ) was prepared and provided to the suppliers that met the screening criteria. A detailed technical and economic evaluation of the suppliers that responded to the RFQ was completed. This resulted in the development of a short list of alternative treatment technology suppliers. In 2006, several suppliers were added to the short list, based on additional screening and a supplemental RFQ process.

Phase II[26]

On February 7, 2007, the City of Los Angeles released a Request for Proposals (RFP) soliciting competitive proposals for a development partner(s) for processing MSW utilizing alternative technologies premised on resource recovery. The development

[25] Request for Proposals for a Development Partner(s) for Processing Municipal Solid Waste Utilizing Alternative Technologies premised on Resource Recovery for the City of Los Angeles, February 5, 2007

[26] Ibid.

partner's(s') responsibilities were to finance, design, build, own, and operate (with the option to transfer to the City after 20 years) the resource recovery facility at a throughput rate of 200-1,000 TPD. The facility was expected to provide diversion from landfill of no less than 80% of the Black Bin material delivered to the facility. In addition, the City considered proposals from emerging/experimental technologies that could process less than 200 tons/day as a potential second facility for testing emerging technologies. The emerging/experimental technology suppliers were to meet requirements outlined by the City in the RFP in order to be considered for the potential testing facility. Proposers of emerging/experimental technologies that did not meet those requirements were not evaluated further.

12.9.2.1.2 Los Angeles County, CA

Phase I – Initial Technology Evaluation[27]

Beginning in 2004, Los Angeles County conducted a preliminary evaluation of a range of conversion technologies and technology suppliers and initiated efforts to identify material recovery facilities (MRFs) and transfer stations (TSs) in southern California that could potentially host a conversion technology facility. A scope of investigation beyond Los Angeles County itself was considered important, as stakeholders in the evaluation extended beyond the County, and the implications of this effort would be regional.

In August 2005, the evaluation report was adopted. Phase I resulted in identification of a preliminary short list of technology suppliers and MRF/TS sites, along with development of a long-term strategy for implementation of a conversion technology demonstration facility at one of these sites. The County intentionally pursued integrating a conversion technology facility at a MRF/TS site in order to further divert post-recycling residual waste from landfilling and take advantage of a number of beneficial synergies from co-locating a conversion facility at a MRF.

Phase II – Facilitation Efforts for Demonstration Facility[28]

In July 2006, the County further advanced its efforts to facilitate development of a conversion technology demonstration facility. The approach was multi-disciplined, including environmental analysis and constructability. Key Phase II study areas included:

- An independent evaluation and verification of the qualifications of selected technology suppliers and the capabilities of their conversion technologies;
- An independent evaluation of candidate MRF/TS sites, to determine suitability for installation, integration and operation of one of the technologies;
- A review of permitting pathways applicable to each technology and site combination;
- Identification of funding opportunities and financing means;
- Identification of potential County incentives (i.e., supporting benefits) to encourage facility development among potential project sponsors; and

[27] Los Angeles County Conversion Technology Evaluation Report ~ Phase II – Assessment, October 2007.

[28] Ibid.

- Negotiation activities to assist parties in developing project teams and a Demonstration project.

The report described progress to date on Phase II and represented a culmination of approximately one year of work conducted by the County. As of November 30, 2007, four companies have been selected to be issued a Request for Offers (RFO) early in 2008 for a demonstration to be constructed at any one of four sites by the selected vendor.

12.10 Summary

This chapter reviewed the current status of the alternative conversion technologies for transforming MSW to electricity or other consumable fuel. It reviewed the residual ash product from the process, the current status of the City and County of Los Angeles' study, and outlined the parameters of a feasibility study for the implementation of a WTE facility.