SECTION 7: WASTE-TO-ENERGY CONSIDERATIONS

A. Current Situation and Issues

The County of Kaua`i's Integrated Solid Waste Management Plan (ISWMP) update, which at the time of print sits before the County Council for adoption, recommends waste-to-energy (WTE) technology among a menu of options for managing the County's solid waste stream. In addition to reducing the volume of waste processed by up to 90%, WTE is an energy source that could have a significant effect on generation capacity. In addition to being identified in the County's ISWMP, WTE has also been identified by KIUC as one of its top two recommended renewable energy projects.

The SENTECH Hawai`i Team conducted a thorough analysis of WTE technologies, met with several manufacturers and developers, and solicited opinions from elected officials and residents of Kaua`i to get the complete WTE picture on Kaua`i.

Over the course of ten stakeholder and five community meetings, the SENTECH Hawai`i Team heard many perspectives on WTE, ranging from:

- "It's dirty, dangerous, unneeded, and way too expensive" to
- "With an aggressive Reduce/Re-use/Recycle campaign, there won't be enough municipal solid waste (MSW) supply to feed the WTE technology, so what, then we import waste from other islands?" to
- "Modern WTE technologies can turn waste into clean energy with only minimum impact on the environment--and that's a lot better than letting unflared landfill gases escape into the atmosphere."

Waste can be seen as an energy resource, and without wanting to wade into the debate on whether or not waste is "renewable" or "clean," SENTECH Hawai`i completed a WTE review in May 2009 and posted results of the review to the Kaua`i Energy Sustainability Plan website at http://kauaienergysustainabilityplan.blogspot.com/2009/06/basics-of-waste-to-energy-on-Kaua`i.html.

In summary, MSW can be directly combusted in WTE facilities as a fuel with minimal processing, known as mass burn; it can undergo moderate to extensive processing before being directly combusted as refuse-derived fuel (RDF); or it can be gasified using pyrolysis or thermal gasification techniques. Each of these technologies presents the opportunity for both electricity production as well as an alternative to landfilling or composting the MSW. The potential benefits of WTE include reduced landfilling (and potential reductions in landfill pollutants to Kaua`i's air, land, and water), reductions in greenhouse gas emissions, and potential useful products and by-products (reformation of syngas or biogas, slag, etc.).

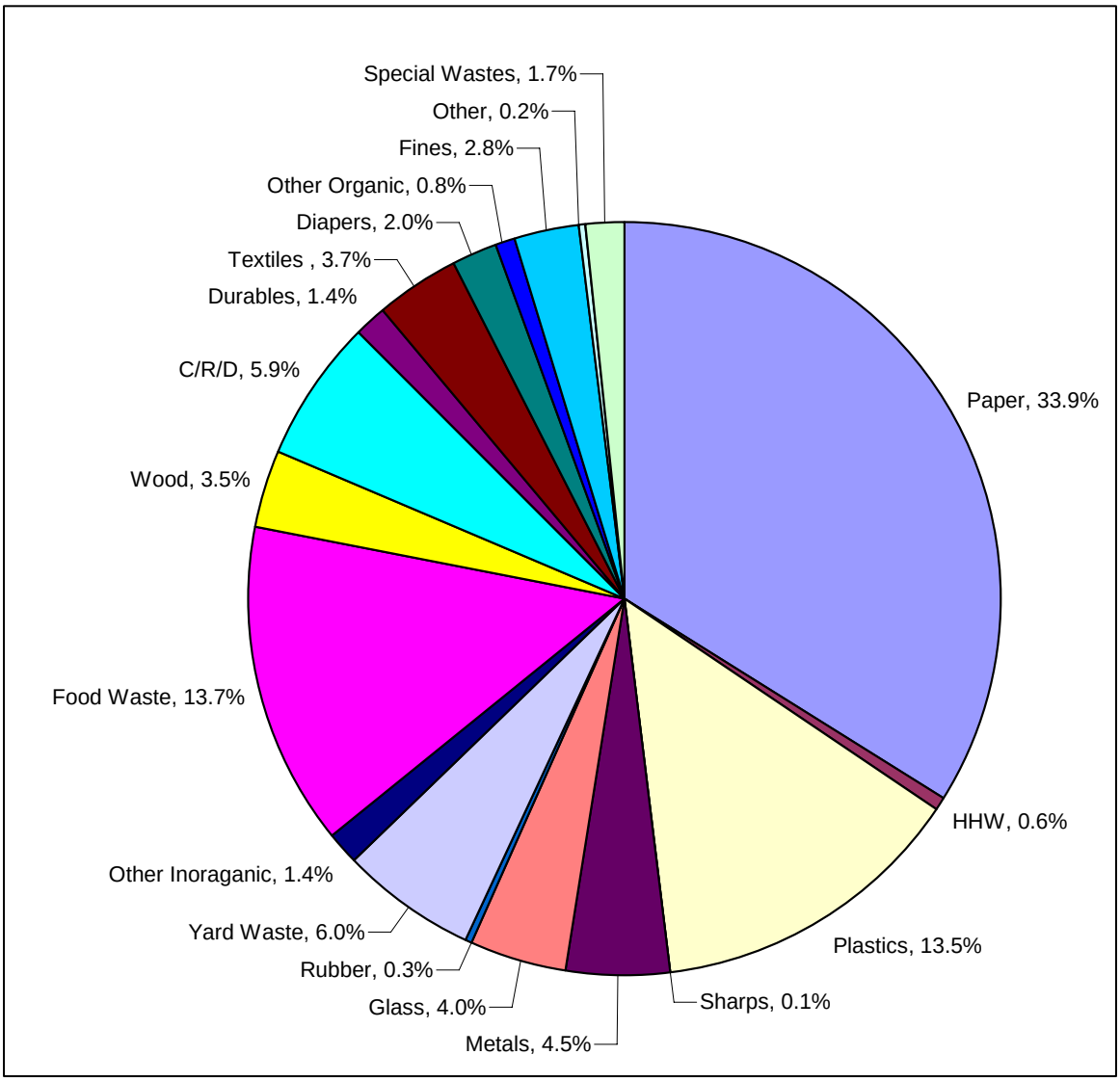
However, in contrast with many other energy technologies that require fuel to be purchased, MSW facilities are paid by the fuel suppliers to take the fuel (a "tipping fee"). This tipping fee would be paid by the County to the WTE facility operator and could potentially be much higher than the tipping fees currently paid at an existing landfill.

The current waste diversion rate for the County of Kaua`i is approximately 25%, with over 250 tons per day (tpd) being sent to the Kekaha Landfill. Phase II of the Landfill has a capacity until

May 2010, at which point a phased expansion would have to take place. Utilizing municipal solid waste (MSW) to generate energy is one potential component of a local energy portfolio.[1]

A sample breakdown of Kaua`i's MSW stream is shown in Figure 7-1 below.[2] This waste characterization was utilized in the Integrated Solid Waste Management Plan (ISWMP) recently drafted by R.W. Beck.

Figure 7-1: Kaua`i ISWMP Waste Characterization



The Solid Waste Advisory Committee (SWAC) provided input to the ISWMP, including concerns the County would not be able to require private waste haulers to deliver their solid waste to a County facility. However, since the SWAC reviewed this information, the United States Supreme Court ruled in *United Haulers Assoc., Inc. v. Oneida-Herkimer Solid Waste Management Authority* that local governments may direct the flow of solid waste to County-

[1] County of Kauai Department of Public Works (). *Public Informational Meeting: MSW Landfill Issues*. Retrieved on 8/23/10 from http://www.kauai.gov/LinkClick.aspx?fileticket=3P1sSc3vtDQ=&tabid=238.
[2] County of Kauai (2009). Personal Communication with Douglas Hinrichs (SENTECH Hawaii, LLC).

owned solid waste management facilities if the purpose of such designation is to promote environmental benefits and/or generate revenues to support local governmental solid waste programs. This ordinance should be supported by a plan explaining the need for flow control in the context of the local government's specific solid waste management system.

The majority of SWAC members recommended WTE over landfill disposal as it met one of their primary goals of reducing reliance on landfill disposal. These SWAC members considered this goal more important than economics, since WTE is a more expensive system than landfill disposal.[3]

Siting of a WTE facility could face significant obstacles, including opposition by local residents, extensive environmental reviews and permitting requirements, as well as opposition by national advocacy groups such as the Sierra Club and the Global Alliance for Incinerator Alternatives (GAIA). Having a WTE facility accepted by the community and successfully sited will require an upfront analysis of all inputs and outputs, including emissions, and a comparison of these with more conventional waste management strategies such as landfills.

Using waste as an energy source may assume that the supply would be constant, which is not unanimously accepted by the citizens of Kaua`i. Many environmentally-conscientious citizens believe that the "Reduce, Re-use, and Recycle" (3R) principle should be applied, possibly in conjunction with a "Zero Waste" initiative being implemented. 3R elements would include a market study for recyclables, a design study for curbside recycling, a fee study for a Pay As You Throw (PAYT) system (which is one of the keys to making curbside recycling work), and the siting and design of a Materials Recovery Facility (MRF).

The ISWMP update projects that, based on the various strategies recommended, Kaua`i's diversion rate will climb from the current 25% to 35% by 2013. This is a relatively low target compared to other Hawaiian islands, as well as other communities on the mainland. Maui County's recently completed ISWMP update estimates a 60% diversion level and Hawai`i County has proposed a resolution integrating Zero Waste Management into their ISWMP update. San Francisco, Long Beach, New York, Los Angeles, San Jose, Fresno and Portland all divert more than 60% of their total waste from city landfills through recycling, green waste and composting programs. In 2006 San Francisco was diverting 70% of their total waste and the city has a goal of 75% in 2010 and Zero Waste by 2020.

If the diversion rate on Kaua`i changes (increases) significantly, it would reduce the amount of waste available to produce power at a WTE facility and potentially have a negative impact on the operations of a WTE facility. The ISWMP waste characterization indicates that 85%, or 314 tpd, of the projected (2009) 369 tpd is combustible waste, with 110 tpd needed for feedstock to the WTE facility. High waste diversion rates of up to 70% would not only reduce the waste stream to about 110 tpd (based on 2009 numbers) but would also significantly change the waste composition. It is unclear what percentage of the 110 tpd would be combustible after diversion of recyclable and compostable materials.

Although WTE could contribute to Kaua`i's non-fossil fuel generation mix, there are clearly many questions regarding the use of this technology on Kaua`i which raise doubt as to when, or

[3] R.W. Beck (March 2009). *County of Kaua'i Integrated Solid Waste Management Plan.* Retrieved on 8/24/10 from http://www.kauai.gov/Government/Departments/PublicWorks/RecyclingPrograms/IntegratedSolidWasteManagementPlan/tabid/445/Default.aspx.

if, WTE will be implemented. Because of this uncertainty, we are recommending that WTE not be included in the plan's "generation wedge" at this time, but that it be recognized as another potential source of renewable energy for Kaua`i that could be utilized in the future.

B. Promising Technologies

A variety of technologies exist that enable energy recovery from waste, each with their own costs, benefits, and challenges. SENTECH Hawai`i completed a WTE review in May 2009 and posted results of the review to the KESP website.[4]

The SENTECH Hawai`i Team now believes that two WTE technologies, **clean incineration** and **gasification**, are viable technical alternatives to the current practice of landfilling and direct venting of gaseous products; and/or the eventual shipping of wastes off-island.

1. Clean Incineration

In Horsholm, Denmark, communities are supportive of a large WTE plant that cleanly burns thousands of tons of household garbage and industrial waste, round the clock. The plant, owned by five adjacent communities, has even proved popular in a conservative region with Denmark's highest per-capita income.

Far cleaner than conventional incinerators, this system features dozens of filters that catch pollutants, from mercury to dioxin, which would have emerged from its smokestack only a decade ago. Emissions from European plants in all categories have been reduced to just 10-20% of levels allowed under the European Union's strict environmental standards for air and water discharges. At the end of the incineration process, the extracted acids, heavy metals and gypsum are sold for use in manufacturing or construction. Small amounts of highly concentrated toxic substances, forming a paste, are shipped to one of two warehouses for highly hazardous materials.

Recycling is done as a first step, and the actual waste percentage breakdown is[5]:

- 61% is recycled;
- 34% is incinerated at WTE plants;
- 4% goes to landfills;
- 1% is hazardous materials—chemical, paints and some electronic equipment—that goes to "special disposal."

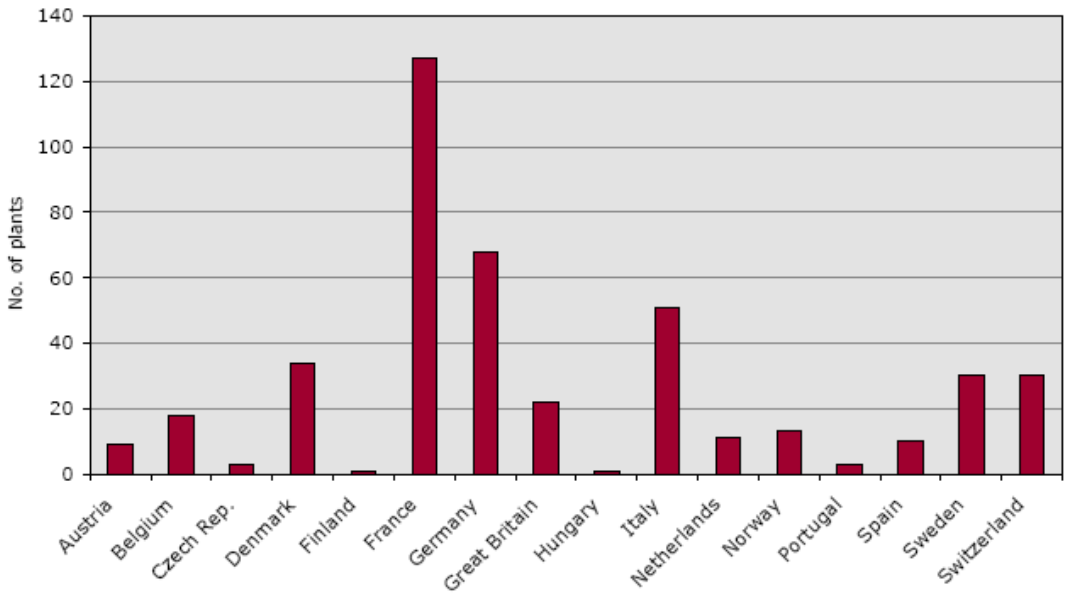
This new type of plant converts local trash into heat and electricity. The WTE plant system is modular with four WTE units; each unit has a capacity of 10 tons/hour of waste to be combusted. Outputs are biased in favor of heat (2,080 kWh of heat and 740 kWh of electricity per ton of combusted waste), which would not be an ideal mix for a tropical island such as Kaua`i. On Kaua`i, the system could be optimized to use the heat in a combined cycle turbine, which is more efficient than a regular turbine, or excess heat could be used to air condition/dehumidify a cluster of buildings much like universities do with district cooling with heat-driven absorption chillers.

[4] Kaua`i Energy Sustainability Plan website blog (June 2009), http://kauaienergysustainabilityplan.blogspot.com/2009/06/basics-of-waste-to-energy-on-kauai.html.
[5] New York Times (April 12, 2010). *Europe Finds Clean Energy in Trash, but U.S. Lags.* Retrieved on 8/23/10 from http://www.nytimes.com/2010/04/13/science/earth/13trash.html?pagewanted=all.

Similar plants have become both the mainstay of garbage disposal and a crucial fuel source across Denmark, from wealthy exurbs like Horsholm to Copenhagen's downtown area. Their use has reduced the country's energy costs, benefited the environment, diminished the use of landfills and cut carbon dioxide emissions.

The clean incinerator WTE plants have acquired considerable cachet as communities like Horsholm vie to have them built. Denmark now has 29 such plants, serving 98 municipalities in a country of 5.5 million people, and 10 more are planned or under construction. Across Europe, there are about 400 plants, with Denmark, Germany and the Netherlands leaders in expanding them and building new ones.[6] Figure 7-2 illustrates the number of WTE plants across 16 countries in Europe as of 2005[7]; since then, the number of WTE plants has only grown.

Figure 7-2: WTE Adoption in Europe, 2005



2. Gasification

A promising WTE technology includes gasification, a method for extracting energy from many different types of organic materials, relying on chemical processes at elevated temperatures greater than 700°C. Gasification is a thermochemical process that converts any carbon-containing material into a synthesis gas (or "syngas," which consists primarily of carbon monoxide and hydrogen) that can be used as a feedstock to make value-added biofuels and biochemicals, as a fuel for combined cycle power generation, or as a replacement for fossil fuels. Gasification (and plasma gasification) can process many more types of waste and do not necessarily require pre-sorting. Gasification is potentially more efficient than direct combustion

[6] Ibid.
[7] International Solid Waste Association (August 2006). Energy from Waste: State-of-the-Art-Report Statistics, 5th Edition. Retrieved on 8/23/10 from http://www.iswa.org/en/290/iswa_publications_detailview/publicationdetail/energy-from-waste-state-of-the-art-report-statistics-5th-edition.html.

of the original fuel because the syngas product can be combusted at higher temperatures or utilized in fuel cells. The product syngas is normally used to fuel a combustion turbine power plant to generate electricity.

There are no current commercial installations of gasification or plasma gasification facilities processing MSW in the U.S., presenting a challenge for obtaining data on startup timeframe, emissions, O&M, and reliability. Very few U.S. gasification manufacturers or developers are willing to share emissions or performance data.

Two companies (and surely others) offer intriguing technologies that may serve Kaua`i's interests. These two companies include Thermo Chem Recovery International (TRI) and Kinsei Sangyo Company, which are discussed further below.

Features of the TRI gasification system, available on O`ahu, include[8]:

- Feedstock flexibility including wood waste, agricultural wastes, energy crops, and refuse derived fuels (RDF), and municipal solid wastes (MSW).
- A system that is fully scalable from 500 dry tons per day of biomass (dtpd) to 2000 dtpd of biomass with a single steam reforming reaction vessel.
- A high quality synthesis gas (H2 and CO) output that can be customized to meet the feedstock needs of the downstream gas to liquids (GTL) or combined cycle (CC) process
- A gasification system that is energy self-sufficient by burning syngas or tail gas from the integrated GTL process.

The TRI system process is illustrated in Figure 7-3. The biomass or MSW feedstock reacts in the gasifier with steam and oxygen in a reducing (oxygen-starved) atmosphere to produce syngas made up primarily of hydrogen, carbon monoxide, carbon dioxide and smaller quantities of methane and other hydrocarbons. The hot combustion gases leaving the pulsed heaters can be sent to a heat recovery steam generator (HRSG) to generate steam. The hot syngas from the reformer is passed through cyclones to remove particulate matter, cooled in a second HRSG, and then quenched and scrubbed.[9]

TRI gasification technology provides wide biomass feedstock flexibility coming in, with a broad range of potential end products going out—including ethanol, biodiesel, and/or energy. By producing multiple products, a biorefinery can take advantage of the differences in biomass components and intermediates and maximize the value derived from the biomass feedstock. With the appropriate design and technologies in place, biorefineries can produce a wide array of renewable biofuels, green energy and electricity and high-value chemicals, all on a carbon neutral basis, which is an environmental improvement over the burning of fossil fuels.[10]

[8] ThermoChem Recovery International, Inc. Website (2009). Retrived on 8/24/10 from http://www.tri-inc.net/tech.html.
[9] Ibid.
[10] Ibid.

Figure 7-3: The TRI System from Feedstock to Fuel

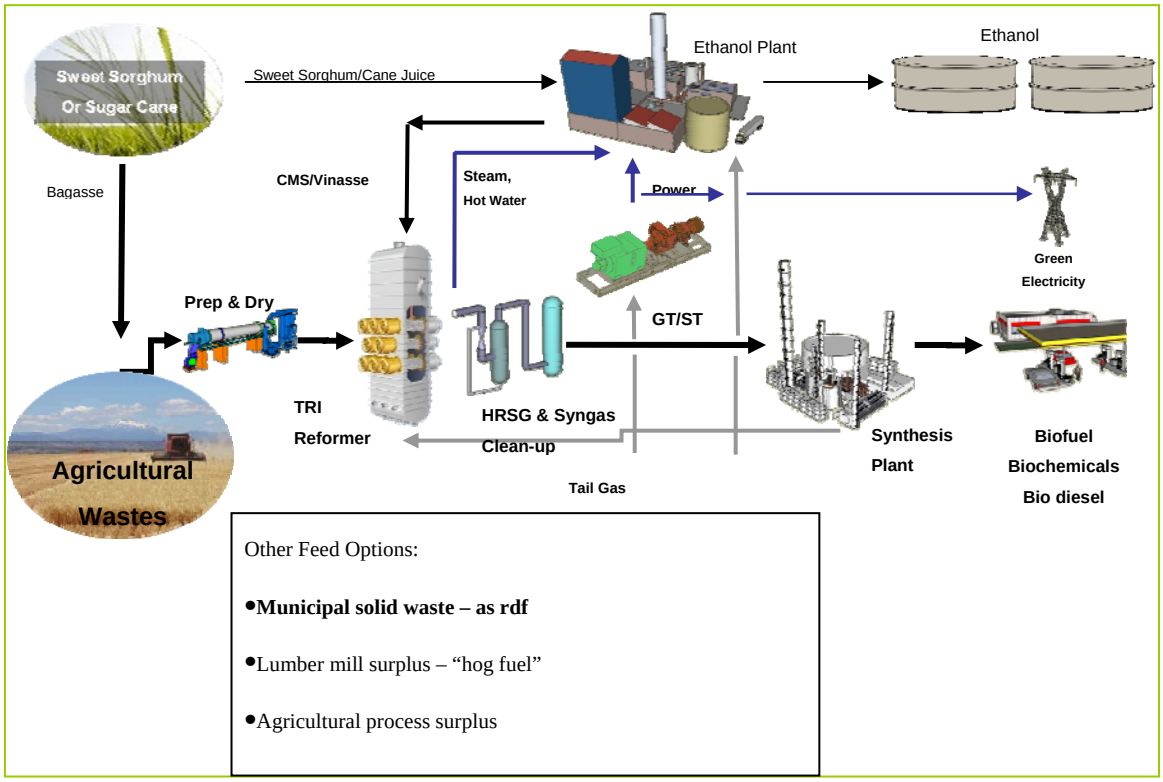


Figure 7-4: One Kinsei Sangyo Company System

WTE technologies such as those from the Kinsei Sangyo Company from Japan may offer possible solutions in solid wastes processing as well.[11] Representatives of this company claim to have invented the world's first solid waste gasification system, *Quad Stage Solid Waste Gasification System.* Kinsei Sangyo's system, photographed in Figure 7-4[12], can supposedly process a wide spectrum of waste, standard and hazardous, without the need of micro separation or classification. Its air emissions have already been tested and certified to be in compliance with Japan, China and European Union standards and will meet EPA requirements. Its ash discharges can be 20%-30% less than similar systems and they are >99% non-organic, therefore non-toxic. Discharged ashes can be used for road paving material, fabric concrete, brick making material and in some cases, as fertilizer. There are more than 250 Kinsei Gasification Systems in daily operation in countries such as Japan, China, Korea, and Malaysia. These systems range from 1-200 tons per day.[13]

[11] Princeton Environmental Group Website (2009). Retrived on 8/23/10 from http://www.princetonenvironmental.com/gasification.html.
[12] Ibid.
[13] Ibid.