Alternative Technologies to Landfills
or:
The Resurgence of Waste-To-Energy (WTE) and Conversion Technologies (CT)…and Don't Forget More Recycling Too!

By
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WTE is Accepted Worldwide

Location	Number of Facilities	Amount of MSW Managed by WTE as % of Total MSW Generated
USA	89	8-15% based on MSW reported by EPA and 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

Source: IWSA website; (statistics as of 2004)

Brescia, Italy

Vienna, Austria

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Some U.S. WTE Factoids

- In 2005, EPA designated WTE energy as renewable energy
- Displaces energy from fossil fuels
- In U.S., some 32 million tons of MSW goes to WTE creating over 2,300 MWs of electricity, while some 138 million tons go to landfills annually
- MSW could generate an additional 6,000 MWs of electricity
- Air emissions
  - Controlled under the federal Clean Air Act; more stringent than for utility and industry boilers
  - 89 existing US facilities meet standards
- Ash management issues
  - Bottom and fly ash generally combined for disposal; contains heavy metals
  - Significant ferrous metals removal at facilities; some non-ferrous; some aggregate and alternative daily cover applications
  - Ash monofills, built to Subtitle D standards, generally used to dispose ash
  - Controlled under the federal Resource Conservation and Recovery Act (RCRA)
  - Periodic toxicity characteristics leaching procedure (TCLP) testing for heavy metals required

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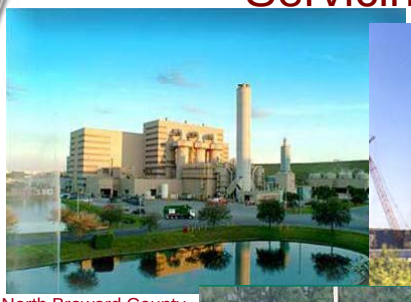
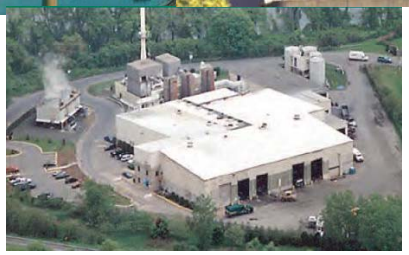
Waste-to-Energy: $14 Billion of Productive Assets Servicing the U.S.



North Broward County, FL

Alexandria/Arlington, VA



Springfield, MA

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New Hanover County, NC WASTEC

- Publicly owned
- 500 TPD
- Mass burn technology
- Produces marketable steam and sells electricity
- Started operations in 1984; 24 years old now
- Availability increased recently to 84%

U.S. WTE Plants by Technology

Technology	Operating Plants	Daily Design Capacity (TPD)	Annual Capacity (1) (Million Tons)
Mass Burn	65	71,354	22.1
Modular	9	1,342	0.4
RDF -Processing & Combustion	10	15,428	4.8
RDF -Processing Only	5	6,075	1.9
RDF -Combustion Only	5	4,592	1.4
Total U.S. Plants (2)	94	98,791	30.6
WTE Facilities	89	92,716	28.7

(1) Annual Capacity equals daily tons per day (TPD) of design capacity multiplied by 365 (days/year) multiplied by 85 percent. Eighty-five percent of the design capacity is a typical system guarantee of annual facility throughput.

(2) Total Plants includes RDF Processing facilities that do not generate power on site.

Source: J.V.L. Kiser and M. Zannes, Integrated Waste Management Services Association, April 2004

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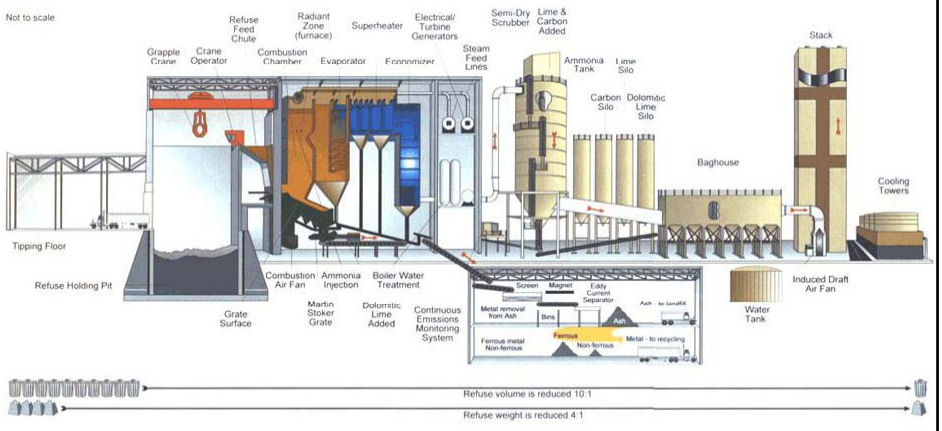
Typical Mass Burn WTE Facility

Covanta Technology Fairfax County, VA



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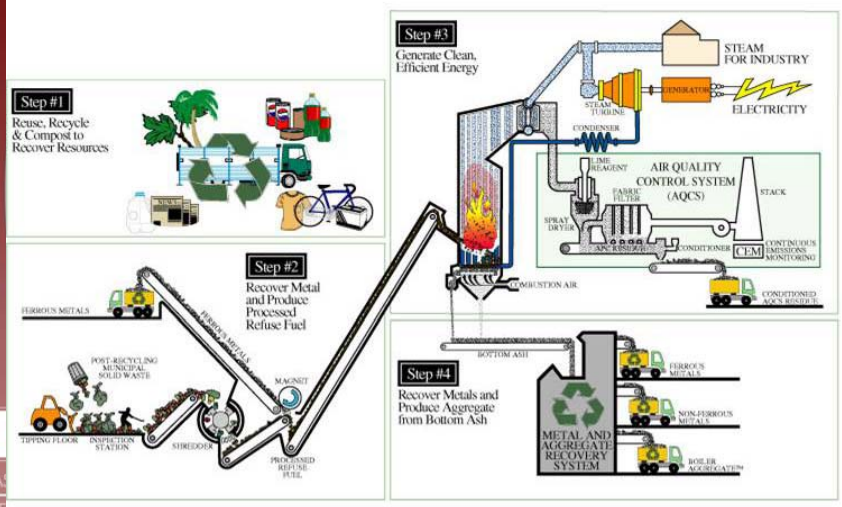
Typical RDF Dedicated Boiler Facility



Source: Energy Answers Corporation

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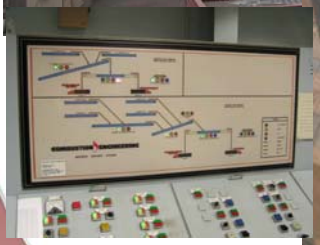
RDF Facility – H-Power Honolulu, HI



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Excel/RRT RDF Production With Remote Boilers

825,000 TPY – 59 MW

COUNTIES:
Dakota
Ramsey
Washington
Benton
Hennepin
Sherburne
Stearns

Elk River RRF


Newport RDF Facility

Great River Energy Plant

Xcel Energy Wilmarth Plant

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WTE Emissions by Technology

Pollutant	Mid-Connecticut RDF	Bridgeport MB	Southeast MB	Wallingford MB	EPA Limits	Units
Particulate Matter	9.66	0.69	8.50	2.47	27	mg/dscm @ 7% O_2
Nitrogen Oxides	137.67	n/r	n/r	144.00	146	ppm
Lead	0.06	0.005	0.01	0.02	0.44	mg/dscm @ 7% O_2
Cadmium	0.0073	0.0008	0.001	0.001	0.04	mg/dscm @ 7% O_2
Hydrogen Chloride	1.03	98.33	27.50	8.50	29	ppm
Dioxin/Furans	0.03	21.80	0.00	10.30	30	mg/dscm @ 7% O_2
Sulfur Oxides	0.10	4.67	n/r	1.67	29	ppm
Mercury	0.005	0.0037	0.005	0.002	0.03	mg/dscm @ 7% O_2
Carbon Monoxide	102.67	25.70	49.50	30.00	200	ppm

n/r = value not reported in source data

Source: Connecticut Resources Recovery Authority, 2006

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Enercon Stepped Hearth

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Alternative…a.k.a. Conversion Technologies

- Biological
  - Aerobic Composting
  - Anaerobic Digestion/ Codigestion
  - Biodiesel
  - Bioethanol
  - Biological Pretreatment
  - Vermicomposting
- Thermal/Chemical
  - Acid Catalysis & Distillation
  - Direct Combustion
  - Gasification/Pyrolysis
  - Microwave Processes
  - Plasma-Arc
  - Thermal Decomposition
- Processing
  - Fiberboard and Construction Composites
  - Refuse Derived Fuels

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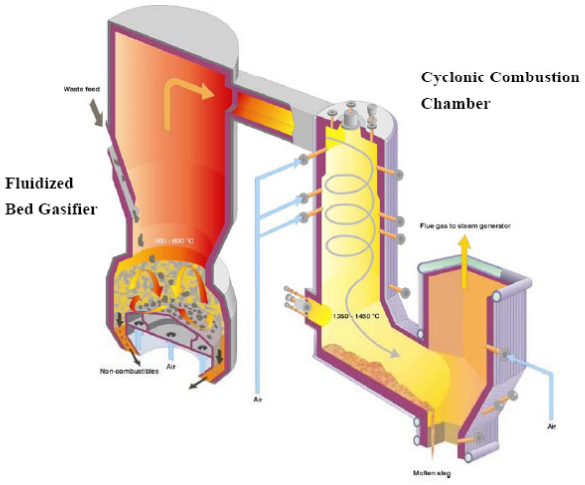
Ebara Fluidized Bed Gasifier and Ash Melter



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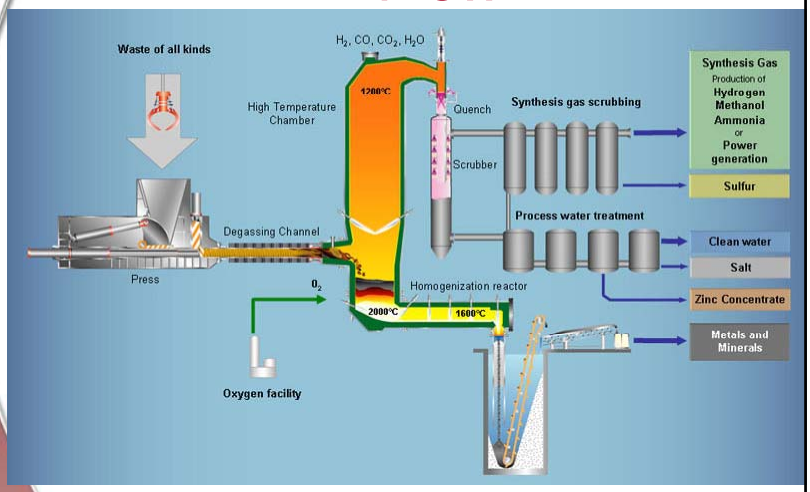
Thermoselect Process Flow



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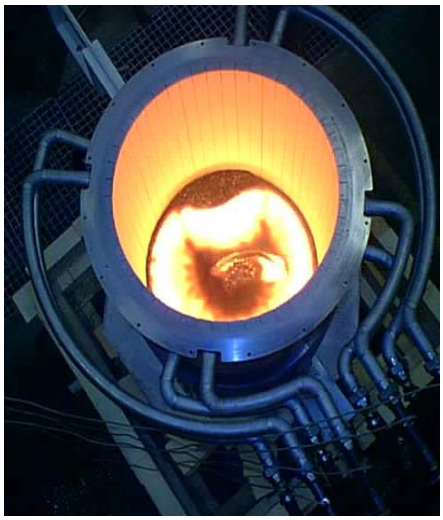
Plasma Furnace - Westinghouse



www.westinghouse-plasma.com

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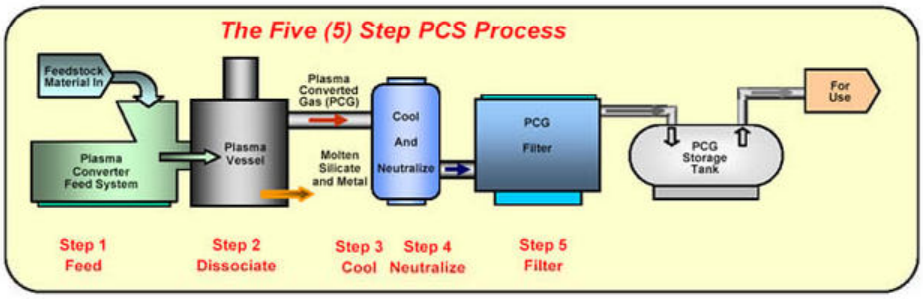
Geoplasma
Plasma Converter System Process



Generates a SYNGAS that is available For Use in power generation

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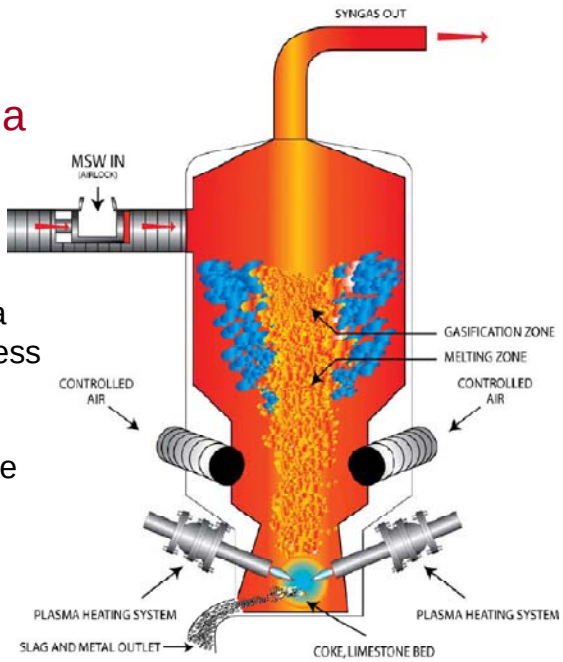
Geoplasma Plasma Vessel

Essentially a Pyrolysis process utilizing Plasma-Arc torches as the heat source



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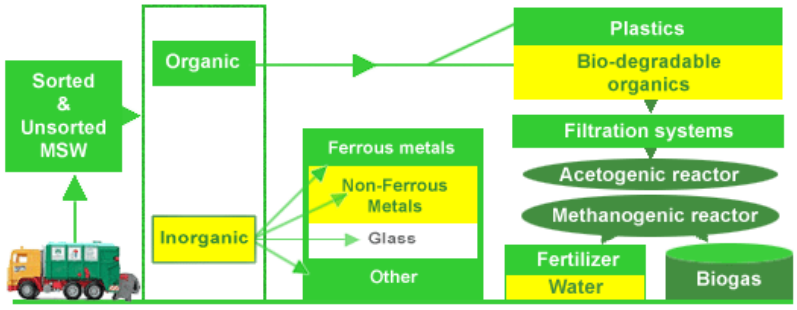
Arrow Bio Process Flow



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ArrowBio Facility – Hadera, Israel

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Commercial Cellulosic Ethanol Plants in the U.S. (Operational or Under Construction)

Company	Location	Feedstock	Capacity (million gallons per year)
Abengoa Bioenergy	Hugoton, KS	Wheat straw	12
Alico	La Belle, FL	Multiple sources	N/A
BlueFire Ethanol	Irvine, CA	Multiple sources	17
Gulf Coast Energy	Mossy Head, FL	Wood waste	70
Mascoma	Lansing, MI	Wood	40
POET Biorefinery	Emmetsburg, IA	Corn cobs	25
Range Fuels	Treutlen County, GA	Wood waste	20
SunOpta	Little Falls, MN	Wood chips	10
Xethanol	Auburndale, FL	Citrus peels	8

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Facilities – Operational & under Development

Pilot in Sherbrooke, C A

Greenfield Ethanol Inc. QC 40 MM gals

Edmonton AB Ethanol 10 MM gals

Recent Planning and Procurement Activities with Waste Processing Technologies in the U.S.

Location	Timeframe - Activity	Number of Respondents
New York, NY	2004 - Study 2007	44 Siting Task Force established and to identify potential sites for pilot facility. RFP to follow
City of Los Angeles, CA	2004 – Study 2005 – RFQ 2007 – RFP	225 screened 26 requested 12 companies submitted proposals; to select for two 200 to 1,000 TPD Facilities
Los Angeles County, CA	2004-05 – Study 2006-07 – Screening 2008 – RFP to be issued	Technologies and sites Companies and sites 4 Selected to go on up to 4 sites
St. Lucie County, FL	2006 – RFQ for Plasma only Geoplasma selected	1 respondent; selected for 3,000 TPD $425 million Facility, product marketing documents being executed. Construction to begin in 6 -8 months permits pending
Hawaii County, HI	2006-07 – RFQ/RFP	3 proposals received; Wheelabrator selected for negotiations. The Hawaii County Council has rejected a $125 million waste-to-energy plant proposed by Wheelabrator, leaving the county with no plan for dealing with Hilo-area trash after 2012

80 Different Companies Responded to the Above Requests!!

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Recent Planning and Procurement Activities with Waste Processing Technologies in the U.S. (Continued)

Location	Timeframe - Activity	Number of Respondents
Frederick and Carroll Counties, MD (NMWDA)	Cooperative agreement signed between counties 2006-07 – RFQ/RFP	8 Pre-Qualified 3 Proposals Received; 2 short-listed
Harford County, MD (NMWDA)	2006-07 – RFQ/RFP	2 Companies Short-listed, best and final offers to be requested, negotiating with Army for sale of steam and electricity
King County, WA	2007 – Study	Under review
City of Sacramento, CA	2007 - RFQ 2008 - RFP	11 Respondents To be released
Broward County, FL	2007 – RFEI 2008	25 Respondents Negotiating w/ Wheelabrator for contract extension
Tallahassee, FL	2006 – Letter of Interest 1/2007 – Negotiation 6/2007 – Vendor selection 6/2007 – Power Purchase Agreement Financing secured	3 Respondents, developer list 2 Respondents added after presentations 1 Respondent negotiating with City

80 Different Companies Responded to the Above Requests!!

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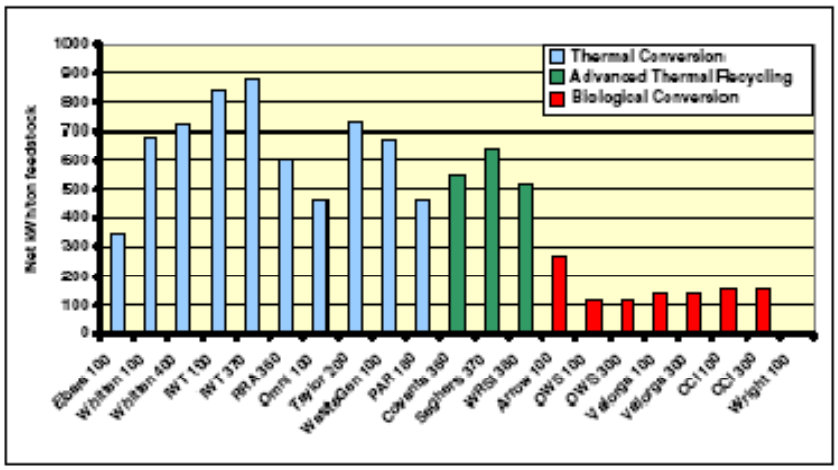
Net Thermal Efficiency
KWHr Per Ton of MSW

Evaluation of Alternative Solid Waste Technologies
City of Los Angeles



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Risk Defined

A measure of the probability that:

1. Technology scaled up successfully
2. Cost in expected range: acquisition cost, capital, operating and maintenance costs
3. System performance standards met
4. Contractor (builder/operator) solvent
5. Contractor continuity throughout term of Service Agreement for technology servicing and operating assistance
6. System has reliability at least at 85% + level
7. System complies with regulatory and permitting requirements and is a good neighbor
8. System and contractor stand up to the legitimate concerns of legitimate NGOs (environmental groups, citizens committees, etc.)
9. System addresses concerns of the legislature or other governmental policy groups and their surrogates, etc.

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Technologies and Risk

Alternative	Risks/Liability	Risk Summary
Mass Burn/WaterWall	Proven commercial technology	Very Low
Mass Burn/Modular	Proven commercial technology	Low
RDF/ Dedicated Boiler	Proven commercial technology	Low
RDF/Fluid Bed	Proven technology; limited U.S commercial experience	Moderate
Pyrolysis	Previous failures at scale, uncertain commercial potential; no operating experience with large scale operations	High
Gasification	Limited operating experience at only small scale; subject to scale-up issues	High
Anaerobic Digestion	Limited operating experience at small scale; subject to scale-up issues	High
Mixed-Waste Composting	Previous large failures; No large-scale commercially viable plants in operation; subject to scale-up issues	Moderate to high
Chemical Decomposition	Technology under development; not a commercial option at this time	High

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Financing Facilities: Public Finance

- Municipal or authority owner
- Revenue bond financing
  - 100% debt
  - Construction and long-term
- Design-build-operate contractor
- Security: services agreement
- Access to long-term residue disposal

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WTE/CT Development Building Blocks

- ❑ Limited and High Alternative Disposal Costs
- ❑ Waste Supply
- ❑ Energy Market(s) and high value for energy sold
- ❑ Site for Facility
  - ❑ Good logistics for waste receipt, energy market(s), and residue disposal
  - ❑ Can be permitted
  - ❑ Accepted by neighbors
- ❑ Landfill for ash and by-pass
- ❑ Contractor
- ❑ Capital
- ❑ Financeability
- ❑ Compatibility with High Level of Recycling
- ❑ Political Will

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When Implementing WTE, Keep in Mind…

- The public will ask for more recycling
  - Opportunity for more diversion:
    - Make residential collection more efficient
    - Single-stream recycling for both residential and commercial sectors
    - Controlling commercial waste stream
- Environmental concerns will be significant
- Site selection critical
- Key cost determinants:
  - Size: larger cost less per ton, economy of scale
  - Value of electricity
  - Location and cost of residue disposal
  - Term of bonds: longer cost less
  - Ownership: publicly owned cost less

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Value of Recyclables in One Ton of Waste Sorted and Sold to Markets

Year	$ per Ton Equivalent
1994	$40.00
1995	$104.00
1998	$48.00
2005	$85.00
2008	$150.00

Source: GBB internal data base

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Reaching Greater Diversion Economically

- Combine tonnages for better economies of scale; implement regionally
- Control both residential and commercial collection
  - And, collected efficiently too!
- Carts and boxes for recyclables
- Contracting
  - Longer term
  - Collection unbundled from processing and disposal
  - Service Fee formula for processing; market risk sharing
- Variable rate pricing, aka Pay as You Throw
- Aggressive and never ending public education and promotion
- Politics on the +++ side

Zero Waste Movement

How much waste is GBB for?

…as little as possible!

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Summary Points

- ❑ Current disposal cost environment is low ($50 per ton) as compared to implementing new proven waste-to-energy ($100 per ton)
- ❑ Landfill disposal for residue/ash and by-pass required
- ❑ Public ownership structure helps assure waste flow control
- ❑ Beware of vendors offering unproven technologies with attractive economics and promises
- ❑ Opportunities for higher level of recycling to increase diversion from disposal

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