



The Status of Waste-to-Energy and Conversion Technologies

**Presented at the
MWMA Fall Summit 2010
Baltimore, MD**

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By

**Harvey W. Gershman, President
Gershman, Brickner & Bratton, Inc.
Fairfax, VA**



GBB Overview





- Headquartered in Fairfax, VA
- Established in 1980 as an objective adviser to governments, institutions, and businesses
- 30 years implementing innovative solutions for waste and recycling industry
- Dedicated exclusively to solid waste management; more focused than broad-based firms
- "Change Agents" to produce better services and facilities

**Celebrating our 30th
Anniversary**




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1st Waste-to-Energy Procurement

Baltimore, MD
(2,250 TPD Wheelabrator BRESCO Plant)



For the
Northeast Maryland Waste Disposal Authority

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Alternative Technologies in the 1970s and early 1980s

- Andco Torrax Gasifier in Niagara, NY
- Black Clawson Hydropulper in Franklin, OH
- CEA Eco-Fuel in Bridgeport, CT
- Columbus, Ohio RDF Burning Power Plant
- Occidental Petroleum, GarbOil in San Diego, CA
- Monsanto Pyrolysis in Baltimore, MD
- Recovery 1 in New Orleans, LA
- Union Carbide Oxygen Pyrolysis in Charleston, WVA
- RDF for Utility Boilers in St. Louis, MO; Milwaukee, WI; Rochester, NY; and Chicago, IL

Why did these projects fail or stop operating?

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EPA's Waste Management Policy

(Previous) waste management hierarchy:

- Source reduction
- Recycling
- Landfilling and incineration

(Current) waste management hierarchy:


- Source reduction
- Recycling
- Incineration/thermal processing with energy recovery
- Landfilling and incineration (without energy recovery)



Source: Rick Brandes, U.S. EPA, 2009

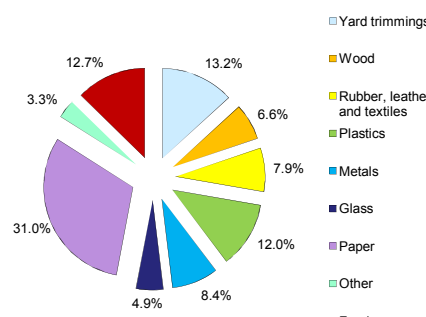
In 2005, EPA designated WTE energy as renewable energy and 35% recycling goal established!

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Waste Facts


- Each person in U.S. today generates 1,643 lbs. per year
 - In 2010, to grow to 1,752 lbs. per year
- What is in our waste?
 - Recyclables
 - Feasible now to recycle up to 50-70%
 - Energy content of remainder: 5,500 BTUs per pound
 - Coal at 9,000 BTUs per pound



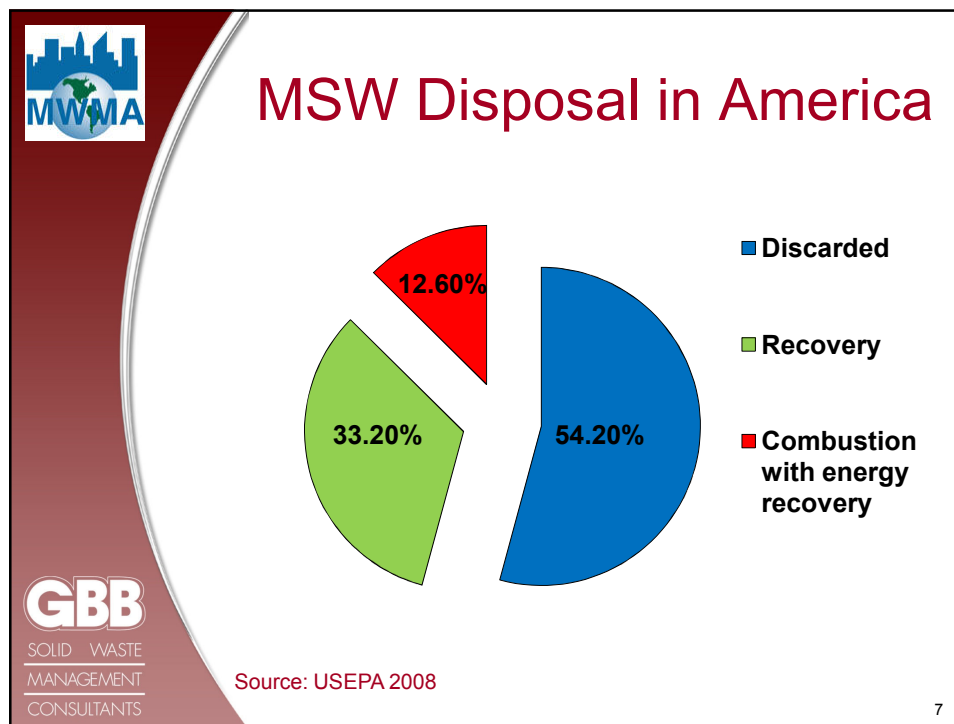
Material	Percentage
Food scraps	12.7%
Yard trimmings	13.2%
Wood	6.6%
Rubber, leather, and textiles	7.9%
Plastics	12.0%
Metals	8.4%
Glass	4.9%
Paper	31.0%
Other	3.3%

Total: 250 Million Tons (Before Recycling)

Source: US EPA, 2008 data



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Waste-to-Energy:

87 Facilities with \$14 Billion of Productive Assets in the U.S.






North Broward County, FL


Alexandria/Arlington, VA

Springfield, MA

Baltimore, MD



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U.S. WTE Plants by Technology


Generating approx. 2,700 MWs

Technology	Operating Plants	Daily Design Capacity (TPD)	Annual Capacity ⁽¹⁾ (Million Tons)
Mass Burn	64	71,354	22.1
Modular	7	1,342	0.4
RDF - Processing & Combustion	12	15,428	4.8
RDF - Processing Only	2	6,075	1.9
RDF – Coal Combustion	2	4,592	1.4
Total U.S. Plants ⁽²⁾	87	98,791	30.6
WTE Facilities	83	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: IWSA (now Energy Recovery Council), 2007 Directory




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WTE Technology & Companies

Company	Technology		
	Mass Burn	RDF	Modular
Babcock & Wilcox	X	X	
Casella		X	
Covanta	X	X	X
Energy Answers*	X	X	X
Foster Wheeler	X		
Veolia*	X	X	
Wheelabrator (WMI)	X		
Xcel Energy		X	

* Covanta purchased Energy Answer's plants in 2008 and Veolia's plants in 2009.


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Dirty MRFs

- Processes MSW to recover recyclable materials through a both manual and mechanical sorting; sorted materials prepared to market specs
- Organics processed further for mulch, compost, RDF, or alternative daily cover (ADC)
- Capable of higher recovery rates than a clean MRF
- Good examples in California with recovery rates of 18 – 48 %
 - Many built or retrofitted to perform as dirty MRFs during 2002 and 2008
 - Capacities range from 1,400 TPD (GreenWaste Recovery Facility, San Jose) to 6,000 TPD (Republic CVT MRF, Anaheim)
- Residuals from Dirty MRFs provide good feed stocks for anaerobic/biological treatment technologies



**Medina County (Ohio)
Solid Waste
Central Processing
Facility**



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Air Emissions of Contenders for WTERT Award in 2006

Emission	WTE-A (mg/Nm ³)	WTE-B (mg/Nm ³)	WTE-C (mg/Nm ³)	Average of 10 Finalists (mg/Nm ³)	EU Standard (mg/Nm ³)	US EPA Standard (mg/Nm ³)
Particulate matter (PM)	0.4	1.8	1	3.1	10	11
Sulphur Dioxide (SO ₂)	6.5	7.5	3	2.96	50	63
Nitrogen oxides (NO _x)	80	11	58	112	200	264
Hydrogen chloride (HCl)	3.5	0.5	0.7	8.5	10	29
Carbon Monoxide (CO)	15	7	15	24	50	45
Mercury (Hg)	0.002	0.005	0.002	0.01	0.05	0.06
Total Organic carbon (TOC)	0.5	NA	0.9	1.02	10	n/a
Dioxins (TEQ), ng/m ³	0.002	0.002	0.015	0.02	0.10	0.14

Source: Themelis, N.J. Thermal Treatment Review. Waste Management World, July-August 2007.




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“Porter: Will burning Durham's garbage make us sick? Even Greenpeace has stopped objecting, but Durham residents aren't convinced”

- “Instead, Durham health officer Dr. Robert Kyle gave the project a green light. His risk assessment didn't say it was 100 per cent safe; he said the risks of additional cancers attributable to the plant would be one in a million.”
- “Recently, the British Health Protection Agency, an arm's-length advisory body made up of professionals and doctors, agreed with him. “Well-managed, modern incinerators are likely to have only a very small effect on health,” the report concludes. Particulates, dioxins, furans, heavy metals — all these things are emitted by incinerators, it states, but at insignificant amounts. (Municipal waste incinerators account for less than 1 per cent of UK dioxin emissions.)”
- The changes were what led Greenpeace to dismantle its anti-incinerator campaign. “A lot of the health-impact concerns about incineration have died away,” says Paul Johnson, principal scientist at the organization's research lab and an author of that damning 2001 report. “The conventional wisdom is with all the emissions control, they are as safe as houses.”

Source: <http://www.thestar.com/news/ontario/oshawa/article/790181>



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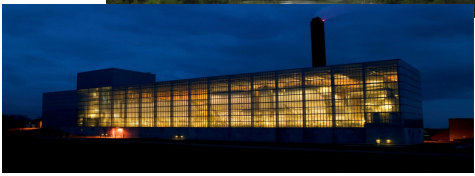





Some Recent Facilities in EU
(Courtesy: Ramboll)

UDDEVALLA
– SVERIGE
300 TPD

SYSÄV –
SWEDEN 2,400
TPD


FASAN – DENMARK
500 TPD






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What if a clock was added to the stack?

*Would the WTE Facility be called
a “Clock Tower”?*





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Recent Activities with Waste Processing Technologies in the U.S.

- Locations that have investigated conversion technology projects:
 - New York, NY; City of Los Angeles, CA; Los Angeles County, CA; City of Sacramento, CA; Tallahassee, FL; Broward County, FL; King County, WA
 - 80 + different companies responded
- Locations investigating conversion technologies:
 - San Bernardino County, CA; City of Glendale, CA; Santa Barbara County, CA
- Locations advancing new facilities with 'proven' technologies:
 - Frederick County, MD (NMWDA); Harford County, MD (NMWDA); Palm Beach County, FL (SWAPBC)
- Mass burn expansions announced/underway/completed:
 - Baltimore, MD; Hillsborough County, FL; Honolulu, HI; Lee County, FL



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U.S. DOE Funds 19 "Biorefinery" Projects for \$564 million, December 2009

Company	Funding		Location	Description
	DOE Grant	Non-fed/Other		
Bluefire Ethanol	\$ 81,134,686	\$ 223,227,314	Fulton, MS	Facility will be constructed to produce ethanol from woody waste, mill residue, and sorted municipal solid waste
BioEnergy International	\$ 50,000,000	\$ 89,589,188	Lake Providence, LA	Process biologically produces succinic acid from sorghum, the process displaces petroleum
Enerkem	\$ 50,000,000	\$ 90,470,217	Pontotoc, MS	The project will be sited on an existing landfill and use feedstock's such as woody biomass in a gasification and catalytic process
NEOS New Planet BioEnergy	\$ 50,000,000	\$ 50,000,000	Vero Beach, FL	The facility will combine biomass gasification and fermentation to process wood, vegetative residues and construction and demolition material
Sapphire Energy	\$ 50,000,000	\$ 85,064,206	Columbus, NM	The project will cultivate algae in ponds the will be converted into green fuels using the Dynamic Fuels refining process
Algenol Biofuels	\$ 25,000,000	\$ 33,915,478	Freeport, TX	The project will make ethanol directly from carbon dioxide and seawater using algae
American Process	\$ 17,944,902	\$ 10,148,508	Alpena, MI	The project will produce fuel and potassium acetate and the plant will have the capacity to produce up to 890,000 gallons of ethanol per year
Amyris Biotechnologies	\$ 25,000,000	\$ 10,489,763	Emeryville, CA	The project will produce a diesel substitute through the fermentation of sweet sorghum and will have the capacity to co-produce lubricants, polymers and other petrochemicals substitutes
Archer Daniels Midland	\$ 24,834,592	\$ 10,946,609	Decatur, IL	The project will use acid to break down biomass which can be converted to liquid fuels or energy. The facility will produce ethanol and ethyl acrylate
ClearFuels Technology	\$ 23,000,000	\$ 13,433,926	Commerce City, CO	The project will produce renewable diesel and jet fuel from woody biomass by integrating ClearFuels and Rentech's conversion technologies
Elevance Renewable Sciences	\$ 2,500,000	\$ 625,000	Newton, IA	The project was selected to complete preliminary engineering design for a future facility producing jet fuel, renewable diesel substitutes, and high-value chemical from plant oils and poultry fat
Gas Technology Institute	\$ 2,500,000	\$ 625,000	Des Plaines, IL	The project was selected to complete preliminary engineering design for a novel process to produce green gasoline and diesel from woody biomass, agricultural residues, and algae
Haldor Topsoe	\$ 25,000,000	\$ 9,701,468	Des Plaines, IL	The project will convert wood to green gasoline by fully integrating and optimizing a multi-step gasification process
ICM	\$ 25,000,000	\$ 6,268,136	St. Joseph, MO	The project will modify an existing corn-ethanol facility to produce cellulosic ethanol from switchgrass and energy sorghum using biochemical processes
Logos Technologies	\$ 20,445,849	\$ 5,113,962	Visalia, CA	The project will convert switchgrass and woody biomass into ethanol using a biochemical conversion process
Renewable Energy Institute International	\$ 19,980,930	\$ 5,116,072	Toledo, OH	The project will produce high quality green diesel from agriculture and forest residue using advanced pyrolysis and steam reforming
Solazyme	\$ 21,765,738	\$ 3,857,111	Riverside, CA	The project will produce algae oil that can be converted to oil-based fuels
Honeywell's UOP	\$ 25,000,000	\$ 6,685,340	Kapolei, HI	The project will integrate existing technology from Ensyn and UOP to produce green gasoline, diesel, and jet fuel from agricultural residue, woody biomass, dedicated energy crops, and algae
ZeaChem	\$ 25,000,000	\$ 625,000	Boardman, OR	The project will use purpose grown hybrid poplar trees to produce fuel-grade ethanol using hybrid technology



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468 (and counting) Companies Offering Technology and/or Development Services

- 13 Aerobic Composting
- 88 Anaerobic Digestion
- 26 Ethanol Fermentation
- 163 Gasification
- 46 Plasma Gasification
- 41 Pyrolysis
- 26 WTE: mass burn, modular, dedicated boilers, and RDF
- 70 Others (agglomeration, autoclave, depolymerization, thermal cracking, steam reforming, hydrolysis)

Source: Gershman, Brickner & Bratton, Inc., September 2010.

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468 By Location

- 290 in the North America
 - 245 in the U.S.A.
 - 45 in Canada
- 137 in Europe
- 41 other countries

- 8 - Australia
- 11 - Austria
- 45 - Canada
- 5 - Denmark
- 4 - Finland
- 7 - France
- 31 - Germany
- 4 - Ireland
- 4 - Italy
- 9 -Japan
- 6 -Switzerland
- 7 - The Netherlands
- 45 - United Kingdom
- 245 – U.S.A.
- 24 – In 13 Other Countries

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Major Companies and Operating Facilities			
Technology	Company	Facilities Operating	Fuel Type
WTE: Mass Burn, Modular, Dedicated boilers, and RDF	AE&E – Von Roll, Inc. (AE&E Group GmbH)	24	MSW, RDF, Domestic, Hazardous and Industrial waste
Anaerobic Digestion	BDI - BioEnergy International AG	28	Used cooking oil, Animal fat, Fatty acid distilla, Trap grease, Rape seed oil, Soybean oil, Vegetable oil, Tallow, Ape seed oil
Anaerobic Digestion	Bedminster International	12	Biosolids, Waste grain, Grease trap waste, Paper dust waste, Cotton gin trash, Chicken litter, Harwood sawdust, Pine bark, Canadian peat moss Perlite, Mined sand, Residential waste, MSW
Aerobic Composting	BEKON Energy Technologies GmbH & Co. KG	15	Unknown
Pyrolysis	Chinook Energy, LLC	16	Scrap metal, Auto shredder residue (ASR), MSW
Gasification	Chiptec	24	chips, sawdust, shavings, clean bio-fuel, agricultural and food processing residue, pallets, paper pellets, rail road ties
WTE: Mass Burn, Modular, Dedicated boilers, and RDF	Covanta Energy (Martin GmbH licensee)	43	MSW
Gasification	Enerwaste (EWI)	11	MSW, Industrial waste, Animal waste, Waste tires, Wood waste, Hospital waste
WTE: Mass Burn, Modular, Dedicated boilers, and RDF	MARTIN GmbH für Umwelt- und Energietechnik	28	MSW
Anaerobic Digestion	Organic Waste Systems OWS nv (Dranco)	19	Mixed waste, Bio waste, Residential waste
Transesterification	Pacific Biodiesel	10	cooking oil, yellow grease, soybean oil, cottonseed oil, canola oil, and tallow, MSW
Ethanol Fermentation	POET, LLC	27	Corn, Grain sorghum, Wheat, Barley, Potatoes.
Anaerobic Digestion	Preseco Oy	10	Animal Slurry, WWTP sludge, Kitchen waste, Industrial biowaste
Gasification/Anaerobic digestion/Aerobic Composting	Urbaser, SA	59	Unknown
Anaerobic Digestion	Valorga International	27	MSW, Sludges, Organic waste, Household waste, Biowaste, Greases
WTE: Mass Burn, Modular, Dedicated boilers, and RDF	Wheelabrator Technologies Inc. (Von Roll licensee)	17	MSW

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Company Technology Development

- 49 with demonstration and/or
pilot facilities
- 42 with R&D and/or test facilities


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Issues to consider in Technology Development

- Performance history and size
- Scaling uncertainties
- Environmental impacts
- Siting and permitting needs
- Cost uncertainties and their \$ coverage
- Product market uncertainties
- Process guarantees
- Financial resources of developer/guarantor
- Community acceptance (work with community; don't surprise them!)
- Other risks and unknowns



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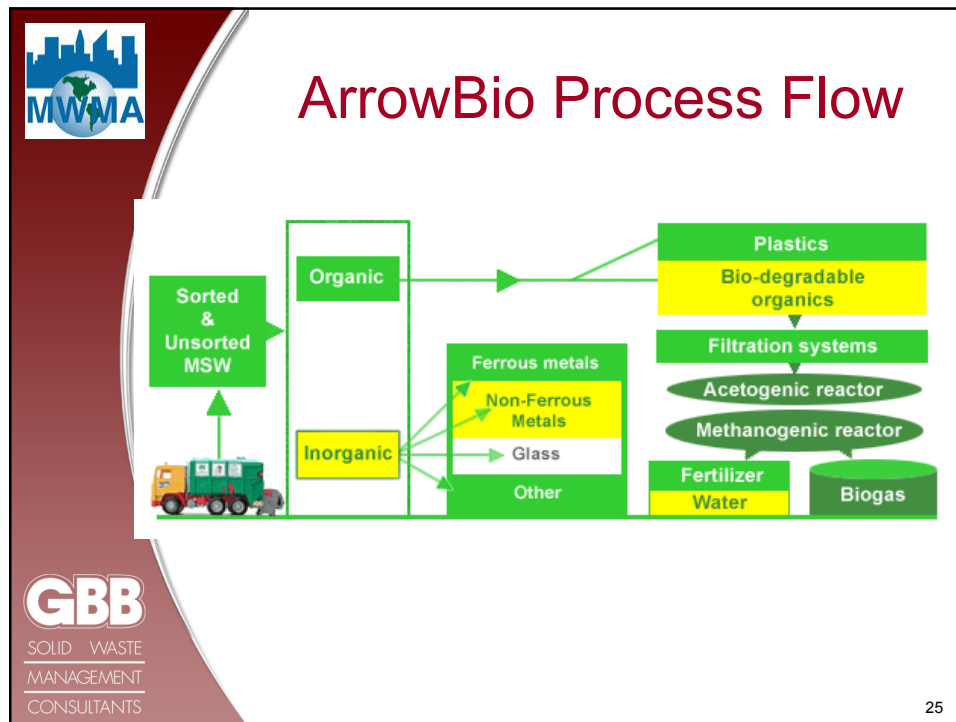


Technologies and Risk

Source: Gershman, Brickner & Bratton, Inc. September 2010

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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ArrowBio – Sydney, Australia



WSN Facility – 300 TPD
Jacks Gully Tank Farm
Fall 2008

April 2010: Los Angeles County announced it wants to advance a 150 TPD ArrowBio anaerobic digestion project at CR&R Inc. in Stanton, CA



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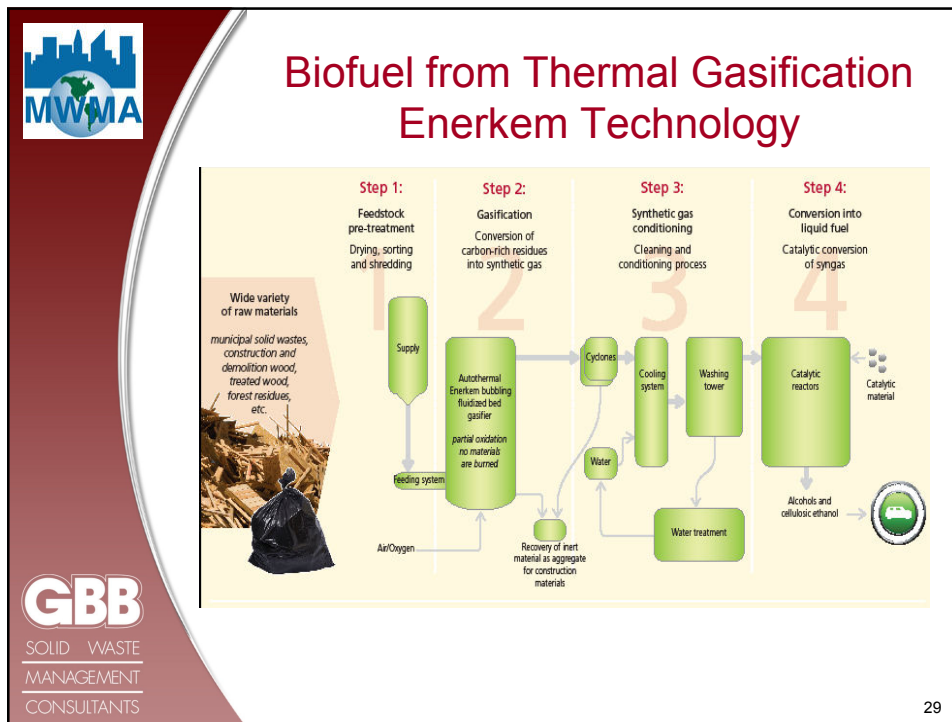


Enerkem

- Gasification and conversion to ethanol
- Pilot plant in Westbury, Quebec
- Catalyst conversion system proven and operational
- Feedstock flexibility



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Edmonton Waste Management Centre


**Enerkem
Edmonton, Alberta**

- Feedstock :** Sorted Municipal Solid Waste
 - 660 TPD to 330 TPD RDF for feedstock
- Total Capacity :** 10 M gallons per year (initially)
- Product :** Syngas, Methanol, Ethanol
- Start date:** 2012
- Approval:** Environmental permit granted
- Good support during public consultation process
- See: www.edmontonbiofuels.ca

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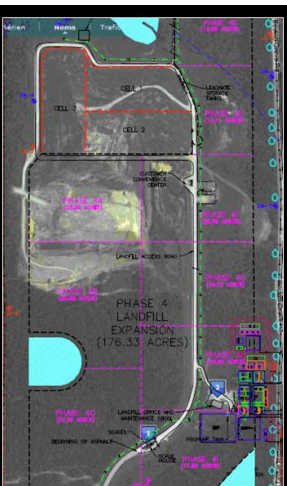




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Enerkem – Pontotoc, MS

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- Feedstock** : Sorted Municipal Solid Waste and wood residues
 - 660 TPD to 330 TPD RDF for feedstock
- Total Capacity** : 10 M gallons per year (initially)
- Product** : Syngas, Methanol, Ethanol
- Start date**: 2012
- LOI signed with the Three Rivers Planning and Development District for MSW feedstock
- Currently in permitting cycle
- Will help recycle and convert 60% of the waste crossing the area's landfill gate
- Awarded \$50M funding from U.S. DOE advanced bio-refineries program





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INEOS Bio Waste into Ethanol

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Process overview

Technology platform

INEOS Bio Ethanol technology

Process overview

Biocatalyst

Gasification

Advantages

Intellectual Property

Pilot plant

Safety & health





INEOS Bio Pilot Plant



Biocatalytic Reactor

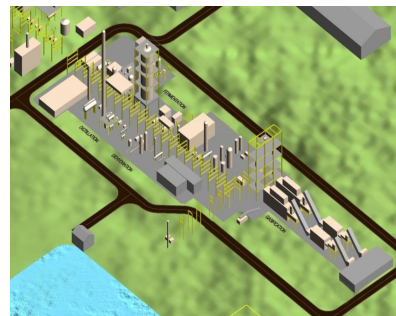


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INEOS New Planet Bio Energy, LLC

- Vero Beach, Indian River County, FL
- In Dec. 2009, received \$50 million DOE grant
- Feedstock: 300 TPD wood, vegetative residues, and C&D materials into ethanol
- 80-100 gallons of ethanol per dry ton of biomass
- Products: 8 million gallons per year and 1-2 MW power
- Completion target: 4th Qtr. 2011



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Lake County, IN Waste-to-Ethanol Project

Genahol Powers 1 LLC


Initially...now

**Powers Energy One
of Indiana LLC**



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Lake County (IN) Solid Waste Management District Waste-to-Ethanol Project

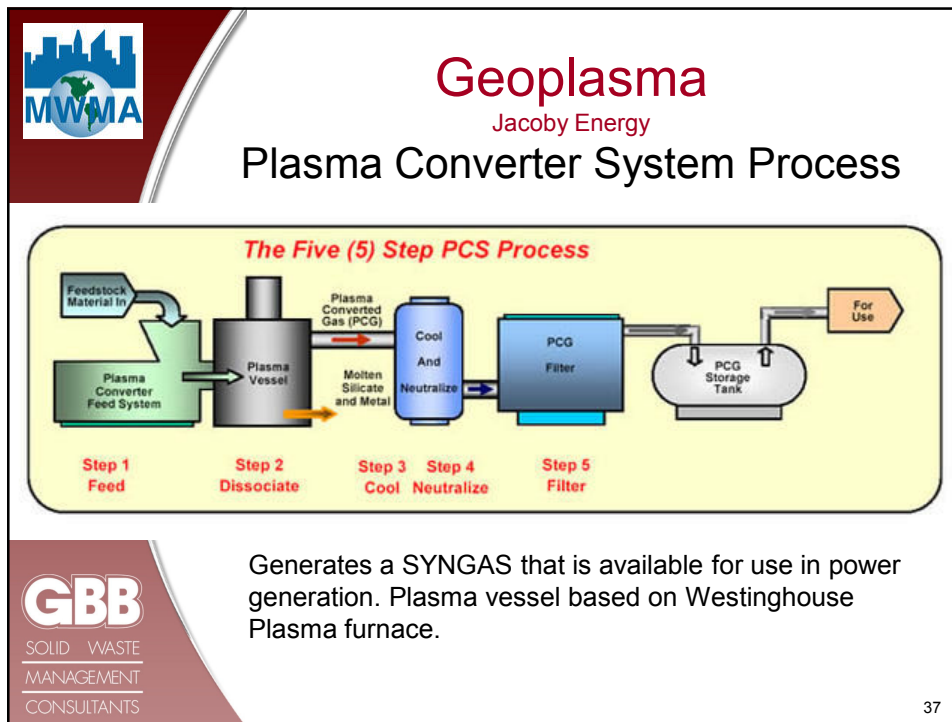
- Powers (developer) to use INEOS technology
- 2,000 tons per day facility with multiple lines sized for 125 tons per day each (16 lines)
- Capital cost: \$256 million
- Plans include expanding to as 10,000 tons per day
- INEOS guaranteeing 90 gallons ethanol per ton MSW input
- Tipping Fee projected to be \$17.25 per ton after 3 cent per gallon ethanol payment to municipalities participating and \$2.50 per ton host community fee to the District
- Service agreements needed with most municipalities in Lake County; many executed


Source: Jeffrey Langbehn, Executive Director; June 2010



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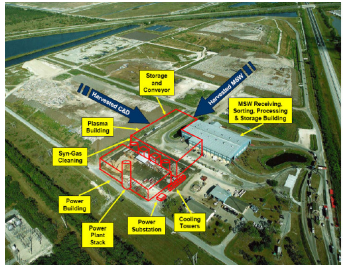




GeoPlasma St. Lucie LLC

Renewable Waste-to-Energy Project

- Feedstock (Tons Per Day) : 525 MSW and 75 tires
- Capital cost: \$125 million
- 9-acre site at County Landfill
- Energy output type(s): approx. 20 megawatts power and steam offload to Tropicana Products
- Owner: GeoPlasma, Atlanta, GA / Energy Resources Group
- Financing method: Private
- Construction Start: First Quarter 2011, subject to permits and financing
- Florida DEP Air Construction Permit Application obtained September 2010
- Operations Start: Mid 2013



Source: GeoPlasma-St. Lucie, LLC and Energy Resources Group, May 2010

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Plasco Energy Group Inc.

- Plasco Energy Group Inc. located in Ottawa, Canada
- Post recycled MSW is shredded for processing in Plasco conversion chamber
- Produces Syngas for electrical generation
- Two operating facilities
 - 94 ton-per-day capacity plant in Ottawa, Canada
 - 5 ton-per-day research and development facility in Castellgali, Spain



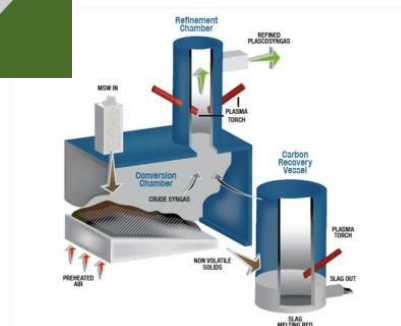
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Plasco Energy Group Inc. Conversion System



Note: Plasco Energy recently announced plans to build plants in Canada and China.



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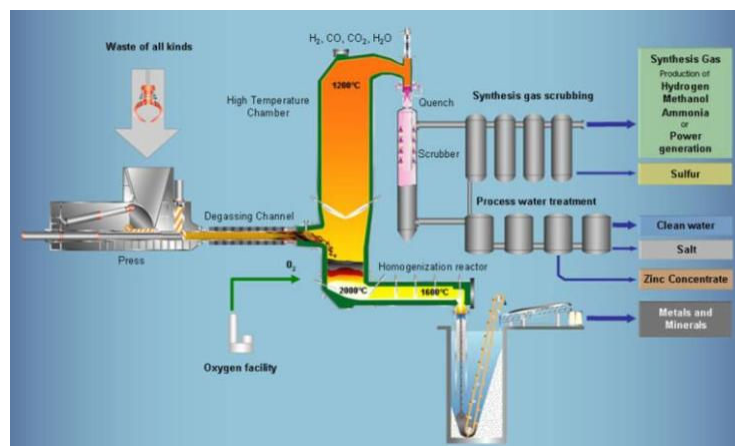
Thermoselect SA - Pyrolysis

- Swiss pyrolysis/gasification technology
- Offered in U.S. by Interstate Waste Technologies, the North American licensee
- Seven facilities with this technology in Japan (with variety of fuels)
- Actively marketing system in U.S.

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Thermoselect Process Flow



No waste preparation or RDF production required

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City of Taunton, MA Solid Waste Management Facility



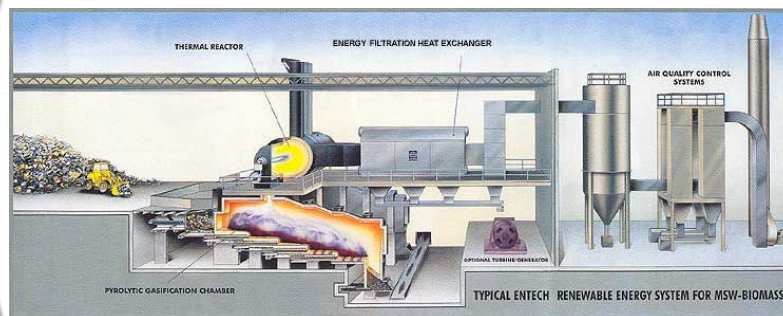
- Awarded through public procurement for non-mass burn incineration technologies
- Design capacity: 1,770 tons per day
- Guaranteed availability: 85.6% or 552,750 tons per year
- Construction cost: \$420 million
- Operating costs: \$55 million
- Estimated Start-up date: Third Quarter 2013
- Electricity Output (initially): sell net 54 Mw; 733 Kwhr per ton
- Ethanol Output (current): 34 million gallons per year; 61.3 gallons per ton
- Other Outputs (Per Input Ton): approx. 20 percent (Aggregate, Metal, Sulfur, Salt, and Zinc Concentrate)
- Net Service Fee: Approximately \$50 per ton
- Owner is IWT Taunton Renewable Energy LLC.
- Financing: debt and equity; to apply for loan under DOE Loan Guarantee Program

Source: Interstate Waste Technologies, May 2010

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Entech Typical Arrangement Advanced Conversion Technology



April 2010: Los Angeles County advances negotiations for a facility at Rainbow Disposal in Huntington Beach, CA

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Bouldin Corp. “WastAway” Process

- Process MSW into RDF; then steam heated and hydrolyzed to make RDF into a “Fluff” product
- Multi-year demonstration operation in McMinnville, TN (two - 2 TPH lines)
- New 2-line commercial plant in Aruba; operational since July 2009
- Selected by developer for two 200-TPD plants on USVI (Fluff into fuel pellets for firing in fluidized bed boilers)



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Summary Points



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More Mixed Waste Processing Like In Our Future

- Many conversion technologies require MSW pre-processing
- Electric utilities required to have 20 percent of demand met through renewable energy and efficiency measures by 2020
- Electric utilities that burn coal could be retrofitted for RDF
 - 10 percent of the coal used equates to 225 millions tons RDF per year



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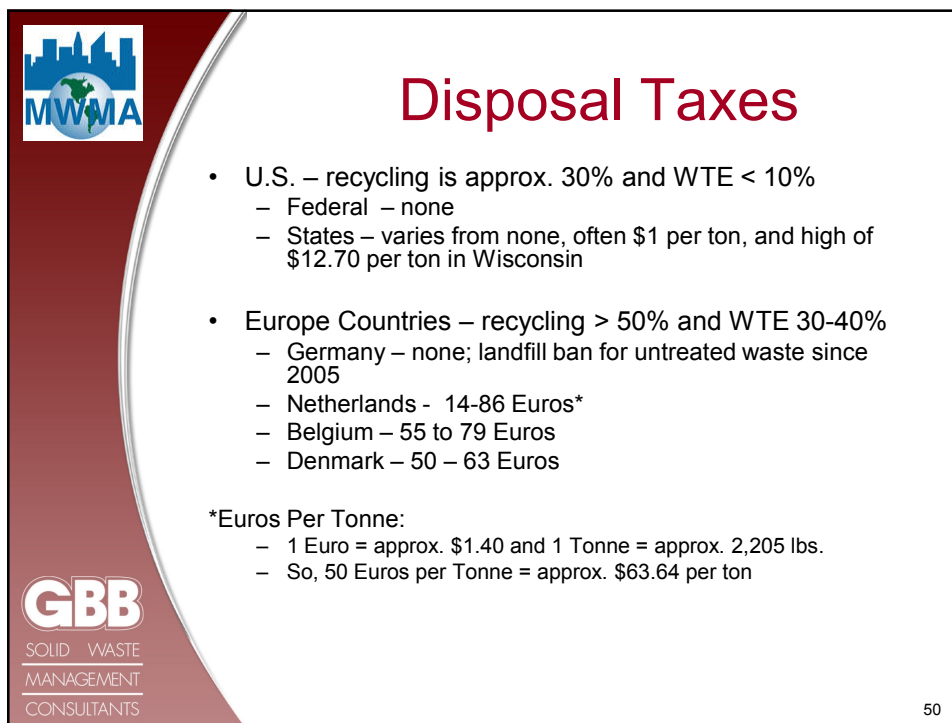
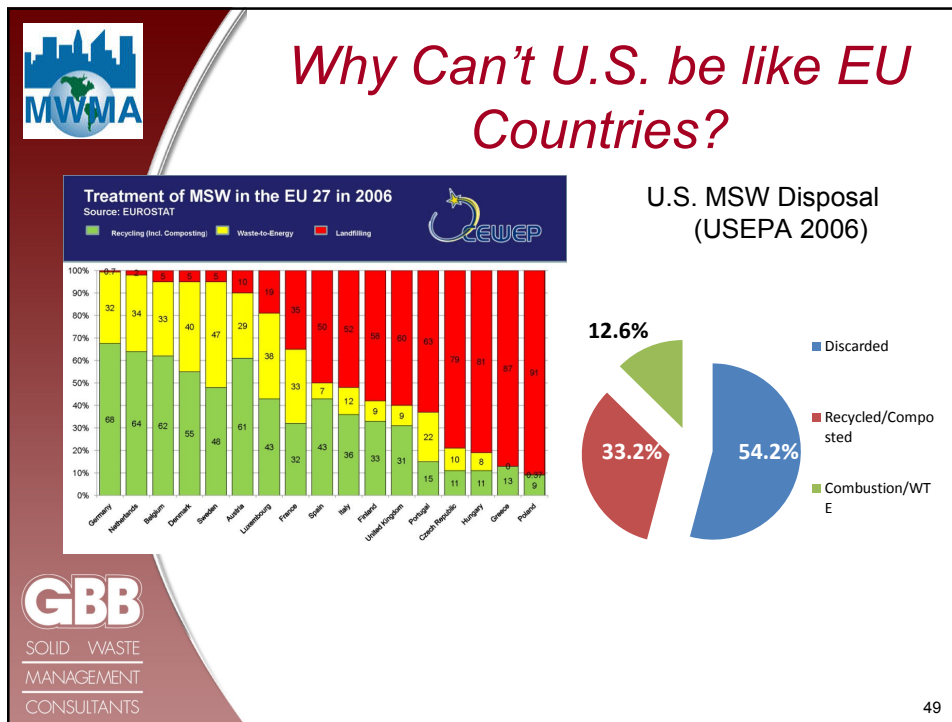


Change Waste, Recycling, and Energy Economics

- Waste disposal is too cheap
- Energy revenues not high enough
- Energy too cheap
 - Federal policy change needed



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Why are we fighting with Zero Waste?

- Set aggressive and sustainable recycling goals in partnership with WTE
- *Do we need soil amendment or fossil fuels displaced?*
- Waiting for unrealistic recycling sends waste to landfills



*How much waste are we for?
...as little as possible!*

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The Ultimate Goal:

Fully Integrated and Efficient Waste Management System with Significant Diversion and WTE ...in a 50-50 partnership!

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Thank you!!

Harvey Gershman

hgershman@gbbinc.com

1-800-573-5801
1-703-663-2424 (office)
1-703-698-1306 (fax)

www.gbbinc.com



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