

**Waste to Energy Conversion
Technology Development
Update and Outlook**



Presented at

**3rd Annual Waste To Clean Energy
Finance & Investment Summit**

July 13, 2011

By

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



Agenda

- Introductions
- Solid waste management overview
- Waste to energy and conversion technologies current status
- Selected alternative technology companies and projects
- Summary
- Q&A



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Introductions

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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

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Celebrating our 30th
Anniversary

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Harvey Gershman



- GBB Founder and President
- Almost 40 years solid waste management experience as advisor to local governments and solid waste agencies
- Recognized expert on WTE and conversion technologies
- Current Federal court receiver for solid waste system of Guam
- SWANA Professional Achievement Awardee - 1993

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**Solid Waste Management
Introduction**

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EPA's Waste Management Policy Changes in 2005

Previous:

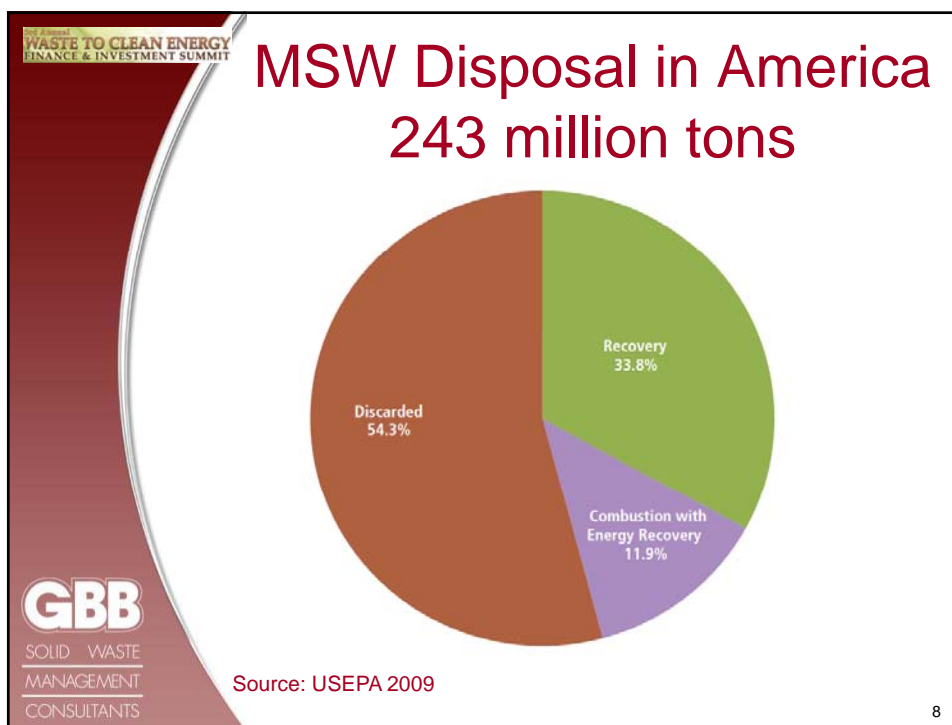
- Source reduction
- Recycling
- Landfilling and incineration

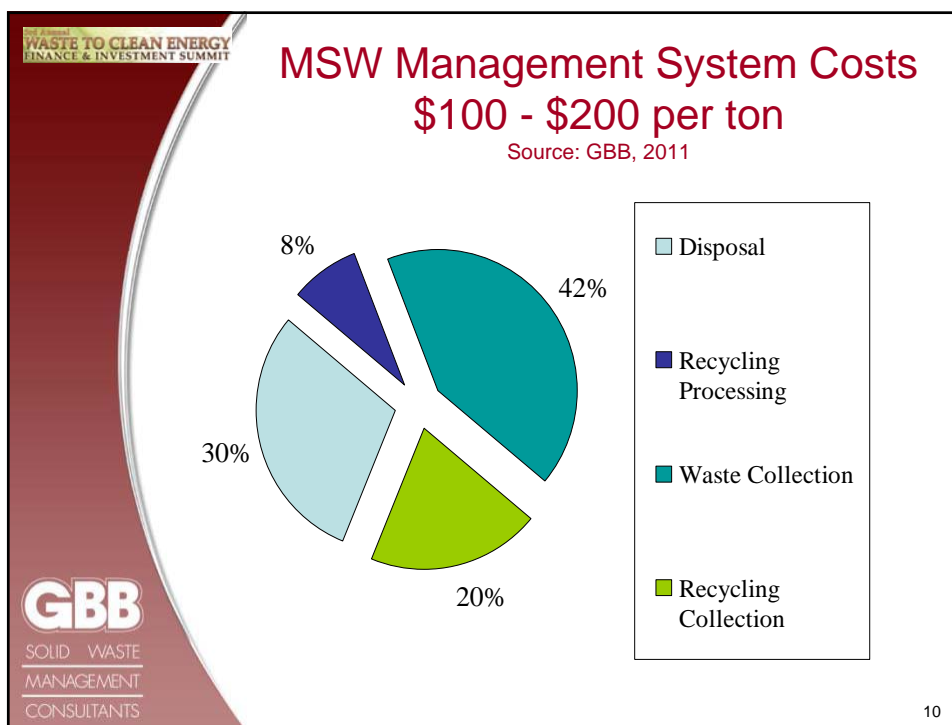
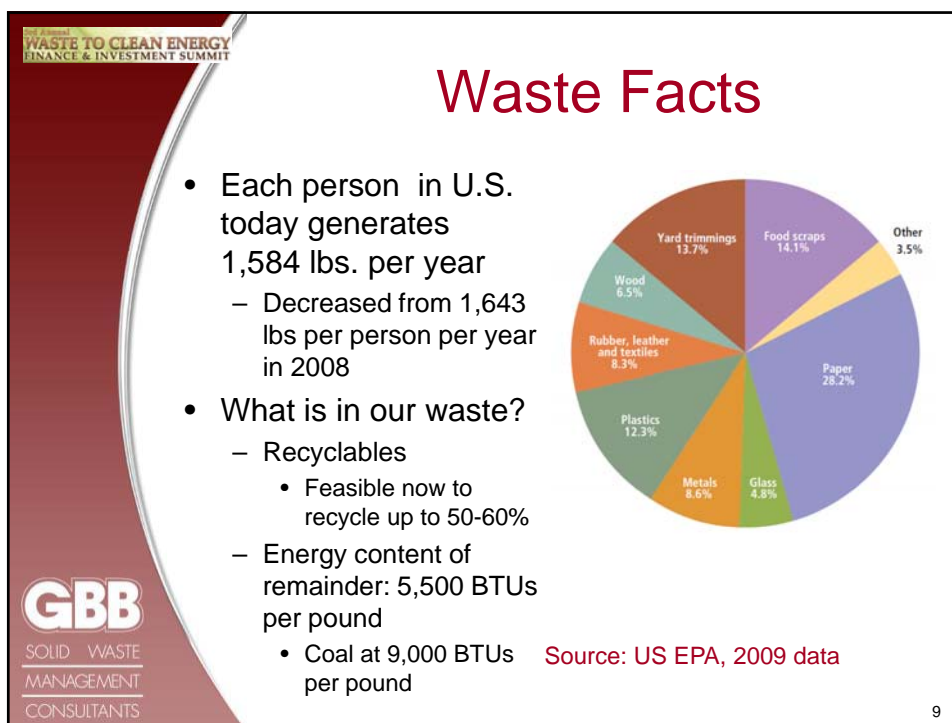
Current:

- Source reduction
- Recycling (35% goal established)
- *Incineration/thermal processing with energy recovery (defined as renewable)*
- Landfilling and incineration (without energy recovery)

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86 U.S. WTE Plants - \$14 Billion in Assets 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	13	16,928	5.3
RDF – Coal Combustion	2	4,592	1.4
Total U.S. Plants	86	94,216	29.2

(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.

Source: IWSA (now Energy Recovery Council), 2010 Directory

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Mass Burn Waste-to-Energy Facilities



North Broward County, FL -
Wheelabrator



Alexandria/Arlington, VA -
Covanta



Springfield, MA -
Covanta



Baltimore, MD -
Wheelabrator

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RDF/Dedicated Boiler Facilities

Rochester, MA - Covanta SEMASS

Hartford, CT - Covanta

West Palm Beach, FL –
Babcock & Wilcox

La Crosse, WI - Xcel

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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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EPA Warm Model Comparison Between Recycling Rates with Composting or Waste to Energy

Baseline Description	Alternative	Total GHG Emissions (MTCO ₂ E/day) from:			Barrels of Oil Saved (bbls/day)
		Baseline MSW Generation and Management	Alternative MSW Generation and Management	GHG Emission or Reduction Difference	
Waste landfilled	20% Recycling	110	(310)*	(420)	523
Waste landfilled	50% Recycling	110	(543)	(653)	907
Waste landfilled	50% Recycling and Rest to Composting	110	(597)	(707)	904
Waste landfilled	50% Recycling and Rest to Waste To Energy	110	(661)	(771)	1,047

*Note: numbers in parenthesis are negative showing reductions in CO₂ emissions.

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Waste to Energy and Conversion Technologies Current Status


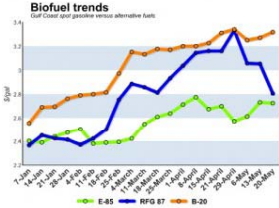
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1 Ton of MSW

- Has 11 million BTUs with 30% moisture
- Equivalent to:
 - 1 barrel of oil
 - ½ ton of coal
 - 11 DT natural gas
- Can make:
 - 5,500 lbs. of steam
 - 400 to 600 KWHrs of electricity
 - 48 gallons of ethanol

What if half of the waste landfilled went to WTE?

...that's 200,000 tons per day of new capacity needed!

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City of Los Angeles
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Locations Advancing “Proven” Technologies in the U.S.

- Mass burn expansions
 - Completed:
 - Hillsborough County, FL - Covanta
 - Lee County, FL - Covanta
 - Olmsted County, MN – Olmsted County
 - Under construction: Honolulu, HI – Covanta
- Locations advancing new facilities with ‘proven’ technologies:
 - Baltimore, MD – Energy Answers
 - Frederick County, MD (NMWDA) - Wheelabrator
 - Harford County, MD (NMWDA) - Wheelabrator
 - City of Los Angeles, CA – Green Conversion Systems
 - Palm Beach County, FL (SWAPBC) – B&W
 - Puerto Rico – Energy Answers
 - U.S. Virgin Islands – Alpine Energy/EPI

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City of Los Angeles
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City of Los Angeles, CA – Green Conversion Systems

- 1,100 TPD post-recycled residential waste
- “Advanced Thermal Recycling”
- MRF recycling @ 29%
- Conversion Technology by Fisia Babcock Environment GmbH (formerly Steinmueller)
- Reference facility: Hamburg, Germany
- Air emissions to be well below permit limits and real time air emission readings to be public
- Emphasis on aesthetics
- Ash processed for aggregates
- Landfill diversion rate @ 99%




Source: http://www.ecoling.ch/englisch/refmva_eng1.htm

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Solid Waste Authority of Palm Beach County, FL

- New Facility - Notice of Award, April 2011
 - 3,000 TPD Mass Burn facility
 - 130 MW renewable power; enough for over 86,000 houses
 - \$668 million construction price
 - \$20.5 million first year O&M cost
 - To use advanced emissions control system



Source: Babcock & Wilcox; artist's rendering of proposed facility.


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Overcoming Procurement and Contracting “Potential Interruptions”

GBB Reports Prepared for the
Solid Waste Authority of Palm Beach County



- “Meeting the Future: Evaluating the Potential of Waste Processing Technologies to Contribute to the Solid Waste Authority’s System (A White Paper)” – September 12, 2009
- “Response to the Florida Chapter of the Sierra Club” – May 3, 2011
- See: www.swa.org ‘Agendas & Minutes’

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Alpine Energy Group, LLC


St. Croix, US Virgin Islands

- Uses Bouldin WastAway refuse derived fuel ("RDF") processing and recycling facility that will convert 200 TPD MSW into approximately 150 TPD RDF
 - Annual pelletized RDF consumption expected to be at least 109,500 tons
- 16.5MW (net) power generating facility
 - To use a wide variety of alternative fuels, including biomass, energy crops, rum bottoms, sewage sludge and tire-derived fuel ; no petroleum coke
- Construction start estimated in Summer of 2011
- Public hearing before the St. Croix Coastal Zone Management Commission in late April 2011

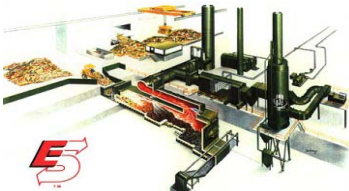


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Enercon Systems




- MSW WTE systems - up to 560 TPD (up to 15 MW)
- MSW "step-hearth" combustors- from 5 to 140 TPD
- Gas cleaning systems - baghouses, scrubbers, etc.; dioxin/furan levels well below latest EPA Regulations
- Three operating facilities in U.S. operating since 1980s
- Also engineer and manufacture: Various incinerators, pyrolysis, dampers, special waste-heat boilers, vitrification systems, and industrial drying systems



Pittsfield, MA



Agawam, MA



Wallingford, CT

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Recent Activities Investigating Conversion Technologies in the U.S.

- Some locations that have investigated technology:
 - Broward County, FL
 - City of Los Angeles, CA
 - City of Sacramento, CA
 - King County, WA
 - Los Angeles County, CA
 - City of New York, NY
 - City of Tallahassee, FL
- Some locations that are currently investigating technologies:
 - City of Allentown, PA
 - City of Glendale, CA
 - City of Plano, TX
 - City of San Antonio, TX
 - Santa Barbara County, CA
 - San Bernardino County, CA

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

- 30 Aerobic Composting
- 106 Anaerobic Digestion
- 34 Ethanol Fermentation
- 170 Gasification
- 47 Plasma Gasification
- 47 Pyrolysis
- 61 WTE: mass burn, modular, dedicated boilers, and RDF
- 68 Others (agglomeration, autoclave, depolymerization, thermal cracking, steam reforming, hydrolysis)

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

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58 Conversion Locations Claimed to Be Operating Commercially with MSW

- 31 Anaerobic Digestion
- 17 Gasification
- 2 Plasma Gasification
- 6 Pyrolysis
- 2 Other (agglomeration, autoclave, depolymerization, thermal cracking, steam reforming, hydrolysis)

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Grants and Loans

Federal

- In December 2009, 19 alternative technologies received a total of \$564 million from DOE for pilot, demonstration and commercial Projects
- *Federal Loan Guarantee Programs*
 - U.S. Department of Agriculture (USDA) Renewable Energy loan guarantee programs
 - U.S. Department of Energy (DOE) Renewable Energy loan guarantee programs

States

- California, Mississippi and Pennsylvania as examples

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Selected Alternative Technology Companies and Projects

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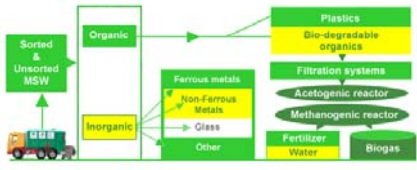
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ARROWECOLOGY
THE WAY TO ZERO WASTE

Hidra, Israel Pilot Plant

- 100,000 tons per year of MSW
- 320 TPD on a 6 days per week basis
- Initial separation of recyclables using water slurry
- 23,000 tons of compost product
- 19,000 tons of residue
- Capital cost \$70K +/- per daily installed ton






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ArrowBio – Sydney, Australia



WSN Facility – 300 TPD
Jacks Gully Tank Farm
Fall 2008

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CR&R Inc. – Perris, CA


- Selected as one of four by Los Angeles County alternative technology projects
- 150 TPD from CR&R dirty-MRF, post-recycled residual output to ArrowBio anaerobic digestion system; convert the biogas generated into biomethane for their truck fleet
- In January 2011, received a \$4.5 million California Energy Commission Alternative and Renewable Fuel and Vehicle Technology Program grant
- Advancing permit approvals


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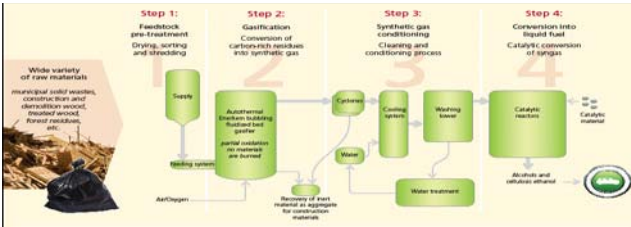
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- Gasification and conversion to ethanol biofuel
- Pilot plant in Westbury, Quebec
- Catalyst conversion system proven and operational
- Feedstock flexibility



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Enerkem

Edmonton, Alberta



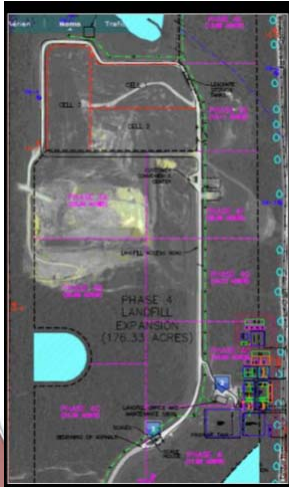
- **Feedstock** : Sorted Municipal Solid Waste
 - 660 TPD to 330 TPD RDF for feedstock
- **Total Capacity** : 10 M gallons per year (initially)
- **Products**: syngas, methanol, ethanol
- **Start date**: 2012
- **Approval**: Environmental permit granted
- Good support during public consultation process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

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Enerkem – Three Rivers Solid Waste Management Authority (Pontotoc, MS)



- **Feedstock** : Sorted Municipal Solid Waste and wood residues
 - 660 TPD to 330 TPD RDF for feedstock
- **Total Capacity** : 10 M gallons per year (initially)
- **Products**: 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 Bio-Refinery Assistance Program

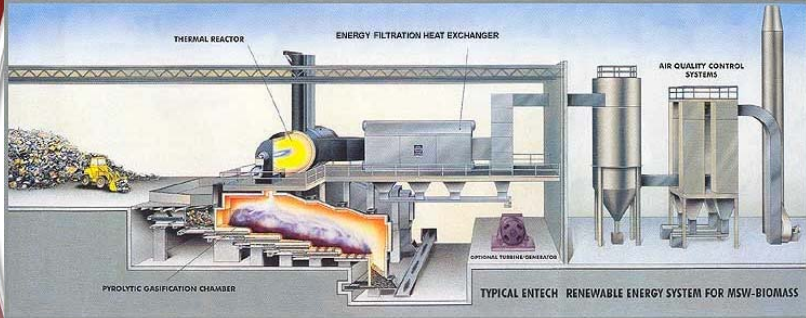
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ENTECH
RENEWABLE
ENERGY
SOLUTIONS

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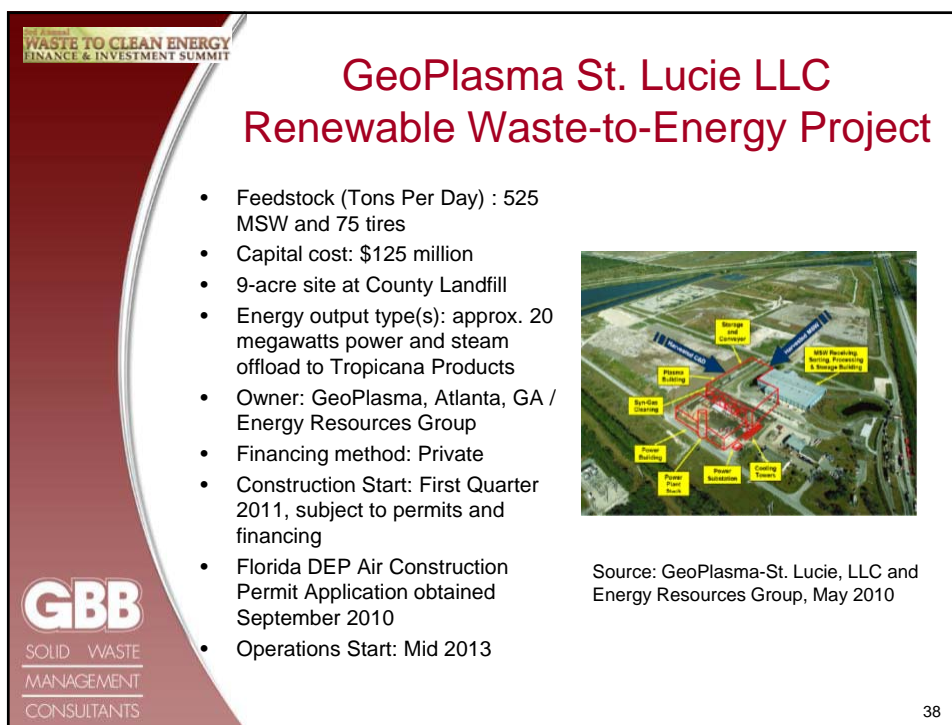
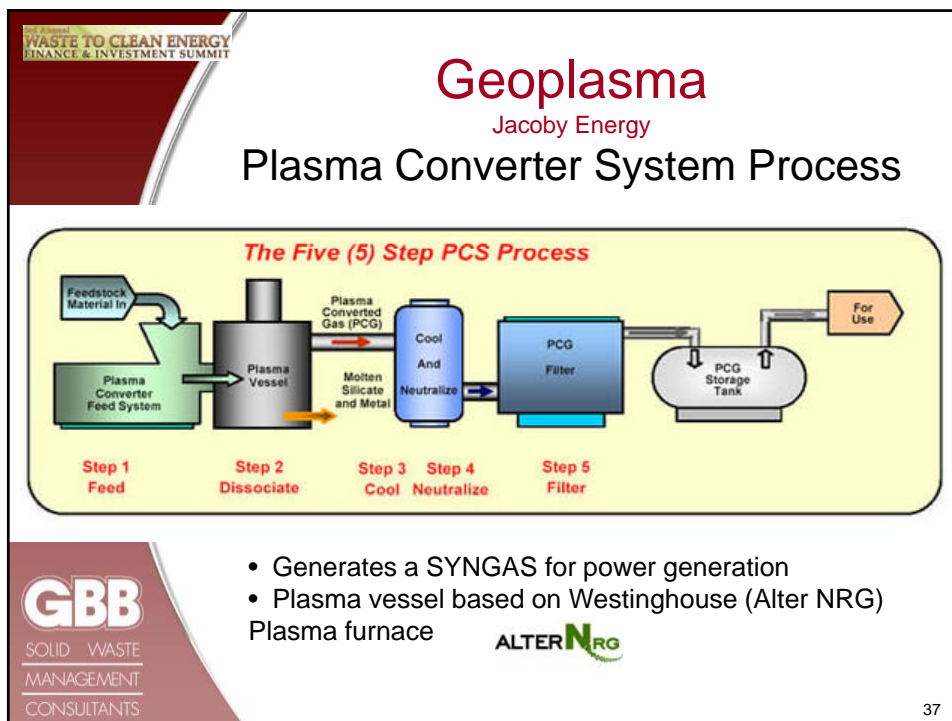
Entech Typical Arrangement Advanced Conversion Technology



TYPICAL ENTECH RENEWABLE ENERGY SYSTEM FOR MSW-BIOMASS

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

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Harvest Power

- Founded in 2008; \$150 million capitalization
- Advanced aerobic composting
 - Produces high quality compost
- Anaerobic digestion and gasification
 - For food and yard waste for power and heat
 - Produces biogas with 15-20% higher methane content than comparable single-stage system
- Named “2010 Emerging Company of the Year” by the New England Clean Energy Council



Aerobic Composting

Fraser Richmond Soil & Fibre Richmond, BC



Anaerobic Digestion

Harvest Bioenergy Centre London, Ontario


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Harvest Power (cont'd)

- Current Facilities**
 - Food Scraps and Yard Debris
 - Richmond, BC – 250,000 TPY
 - Tulare, CA – 70,000 TPY
 - Tullytown, PA – 20,000 TPY
 - Construction and Demolition Waste
 - Urban Wood Waste Recyclers, Vancouver – 220,000 TPY
- Future Sites**
 - London, Ontario (under construction) – 65,000 TPY anaerobic digester to produce 22,000 kWh of energy and 4,000 tons of fertilizer annually
 - Vancouver- partnership with GICON Bioenergie GmbH to construct digestion facility



Tulare County Compost and Biomass Inc.



Urban Wood Waste Recyclers

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INEOS New Planet Bio Energy, LLC Indian River County, FL

- Vero Beach, Indian River County, FL
- In Dec. 2009, received \$50 million DOE grant
- Feedstock: wood, vegetative residues, and C&D materials into ethanol
- 80-100 gallons of ethanol per dry ton of biomass
- The project ground breaking February 2011
- 150,000 tons annually of waste materials from landfills to produce 8 million gallons of fuel-grade ethanol and 6 megawatts of electric power



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

- Powers Energy One of Indiana LLC (developer) to use INEOS technology
- 2,000 TPD facility with multiple lines @ 125 TPD (16 lines)
- Capital cost: \$256 million
- Plans include expanding to as much as 10,000 TPD
- INEOS guaranteeing 90 gallons ethanol per ton MSW input
- Tipping fee projected to be \$17.25 per ton after 3 cents 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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Minimrf LLC

- Process Unsorted MSW for
 - Ferrous and non-ferrous
 - Compostibles; ADC
 - Combustibles (optional engineered fuel module)
- Up to 100 TPH
- Small footprint
- Modular, trailer units
- Partners: Novelis and PRFection Engineering
- Operating unit in Dayton, OH




Source: Steven M. Viny, PRFection Engineering

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- Headquartered in Ottawa, Canada
- Shreds/processes post recycled MSW for introduction into 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
- Shortlisted in Santa Barbara, CA
- Selected by the Salinas Valley Solid Waste Authority (CA)
- Other plans to build facilities in Canada and China




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City of San Jose, CA







City of San Jose signs new contract to boost recycling


- Negotiating new 15-year contracts with two private waste management companies (Allied Waste Services of North America and Zero Waste Energy)
- Technology: dry fermentation anaerobic digestion
- Objective to bring the commercial recycling rate to 80 percent by 2014 from current level of 22 percent

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Thermoselect SA - Pyrolysis



- Swiss pyrolysis/gasification technology
- No waste preparation or RDF production required
- 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.
- Qualified for a project with Los Angeles County, CA and Puerto Rico

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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 Kwh 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

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Source: Interstate Waste Technologies, May 2010

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Some Others To Watch...

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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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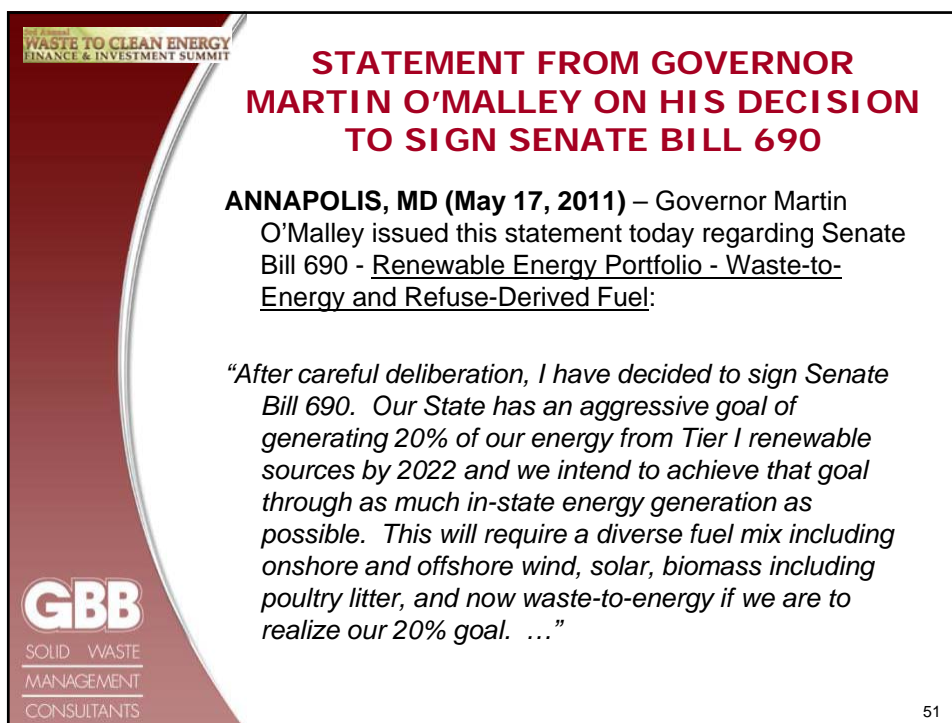
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Economics Holding Back WTE

- Landfill disposal abundant and generally less expensive than WTE
 - *In Europe, landfilling of unprocessed waste banned and/or taxed heavily*
- Recyclables worth a lot
- Energy revenues not high enough
 - Power alone not enough
 - Cogeneration and or combined heat and power applications help
 - Liquid fuel products have much higher value
- Making collection more efficient can create financial capacity for more recycling and higher cost WTE

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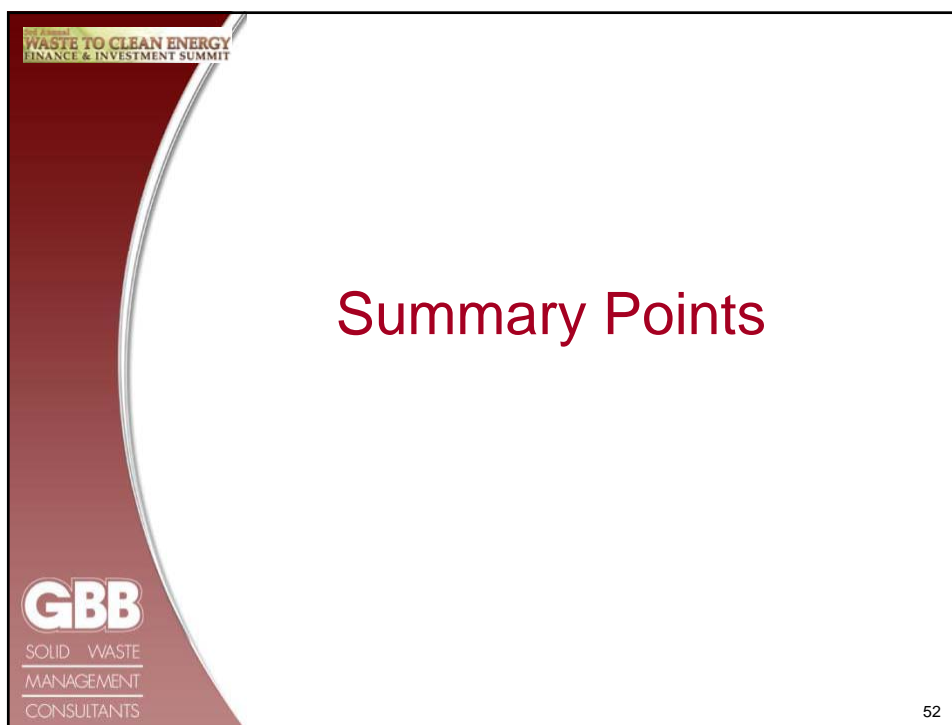
STATEMENT FROM GOVERNOR MARTIN O'MALLEY ON HIS DECISION TO SIGN SENATE BILL 690

ANNAPOLIS, MD (May 17, 2011) – Governor Martin O'Malley issued this statement today regarding Senate Bill 690 - Renewable Energy Portfolio - Waste-to-Energy and Refuse-Derived Fuel:

"After careful deliberation, I have decided to sign Senate Bill 690. Our State has an aggressive goal of generating 20% of our energy from Tier I renewable sources by 2022 and we intend to achieve that goal through as much in-state energy generation as possible. This will require a diverse fuel mix including onshore and offshore wind, solar, biomass including poultry litter, and now waste-to-energy if we are to realize our 20% goal. ..."

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Summary Points

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Trend for Future

- New technologies will need 4-6 years to learn if they work and their economics
- Added economic benefit of placing value on carbon credits and power from waste as 'renewable energy'
 - Possible impetus for more proven technologies that are now deemed too expensive
- Renewable fuel standards from EPA and added recycling requirements

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Trend for Future (Cont'd)

- Low risk assumption by public sector until new technologies proven
- Continued demand for recyclables; industry wants more paper, aluminum, and plastics
- More mixed waste processing again
 - Many conversion technologies require MSW pre-processing
 - Electric utilities may become a player for RDF
- 'Environmentalists' and 'Zero Waste' proponents will continue to fight WTE and conversion technologies calling them all "incineration"

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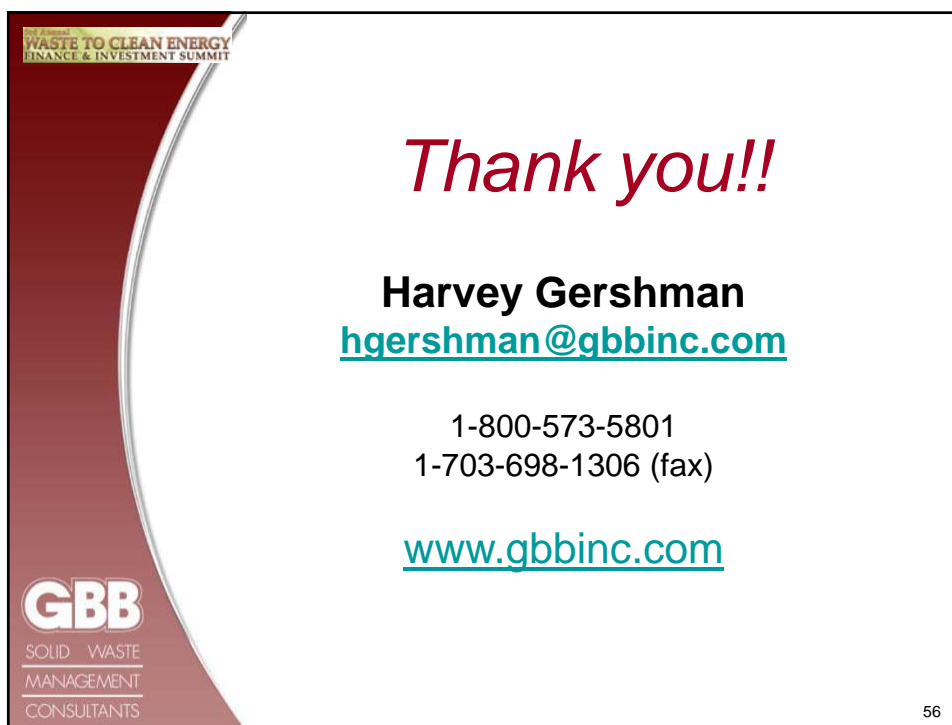
The Ultimate Goal:

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

...for more jobs, better environment, and energy independence!

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Thank you!!

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