Waste-to-Energy and Alternative Conversion Technologies – Experience & Opportunities

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By
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Intro - GBB Overview

- Headquartered in Fairfax, VA
- Established in 1980 as an objective adviser to governments, institutions, and businesses
- Focus exclusively to solid waste management
- 30+ years implementing innovative solutions for waste and recycling industry
- Owner's representative and feasibility reports for financings
- "Change Agents" to produce better services and facilities

GBB
SOLID WASTE MANAGEMENT CONSULTANTS

GBB Waste to Energy and Conversion Technology Services

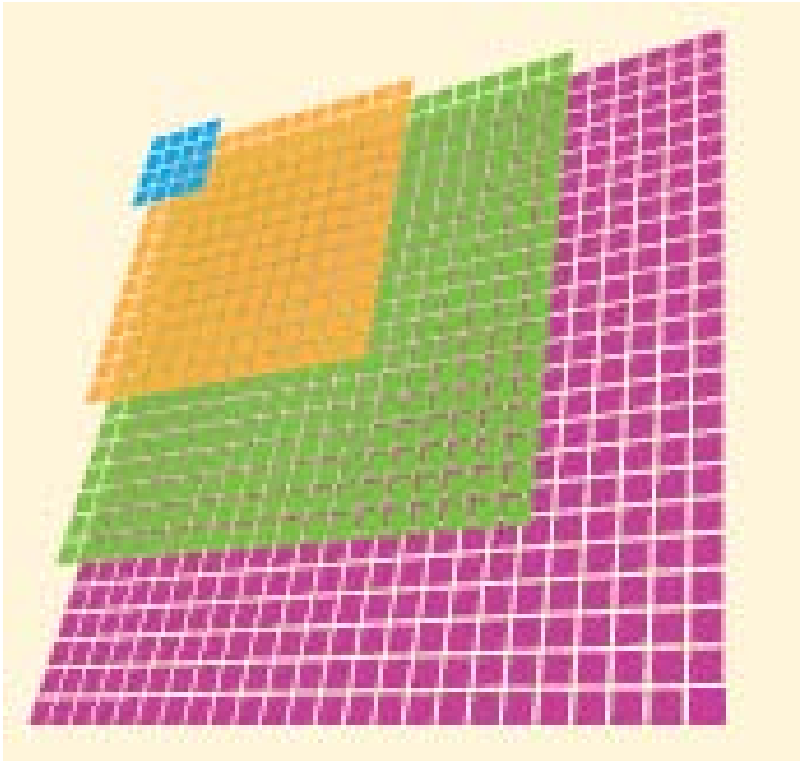
- Reviews addressing economic feasibility, technology effectiveness, environmental issues, and procurements, and project development support for retrofits or new facilities:
  - City of Allentown, PA
  - City of Annapolis, MD
  - Marion County, OR
  - County of Maui, HI
  - New Hanover County, NC
  - Orange County, NC
  - City of Plano, TX
  - Prince William County, VA
  - Rhode Island Resource Recovery Corporation
  - Solid Waste Authority of Palm Beach County, FL

- Due diligence reviews and Independent feasibility consultant

Renewable Energy Technology Land Use

Note: Waste-to-Energy uses less land per megawatt than other renewable energy sources

- WTE facilities require an average of 0.7 acres/MW
- Landfill gas requires 27 acres/MW
- Solar requires 8 acres/MW
- Wind requires 18 acres/MW



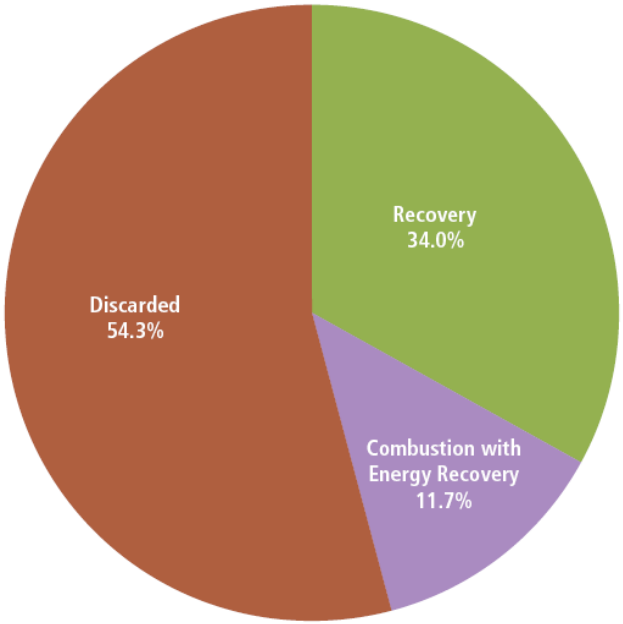
Source: Covanta Energy, 2012

Solid Waste Reduced, But .... Not Going Away

	1980	2010
Solid Waste Generation	3.66 #/Capita/Day	4.43 #/Capita/Day
Amount Recycled	<10%	34%
Disposed of in Landfills	89%	54%

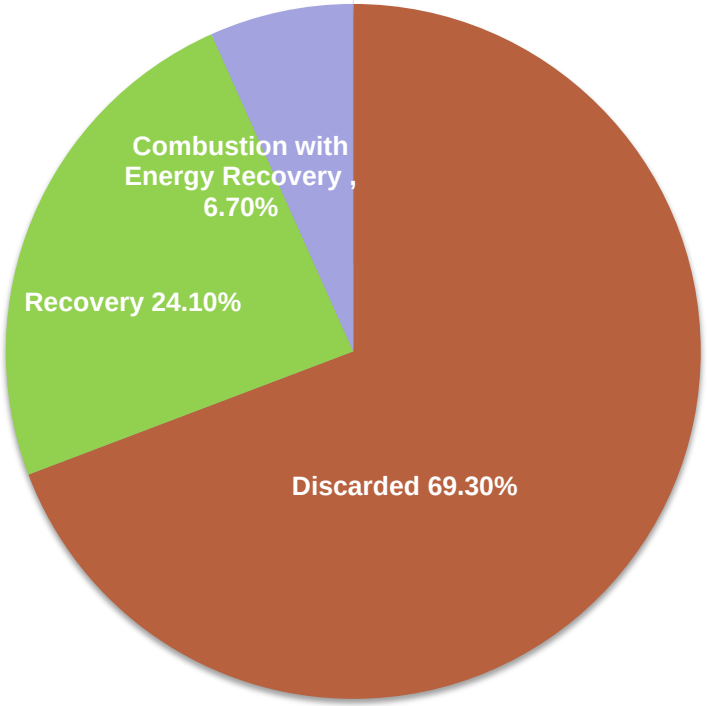
Source: USEPA

MSW Management in the U.S.



EPA Estimate: 250 million tons

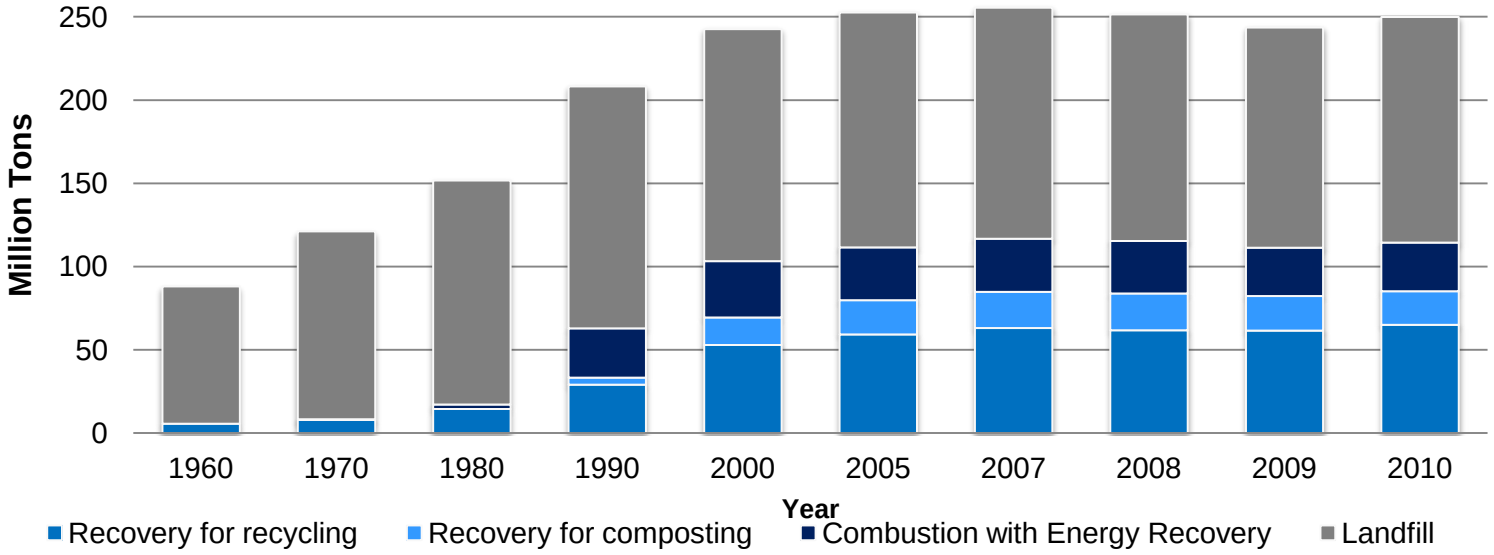
2010



Biocycle Estimate: 389 million tons

2008

Capacity for Growth



The total installed US WTE capacity in 2010 was 2.7 GW, combusting 11.7% of the nation's MSW

If half of landfilled waste went to WTE → over 9 GW
(In 2011, 24.7 GW of announced coal power plant retirements)

Source: USEPA, 2010

Factors Contributing to Increased Interest in WTE and CT's

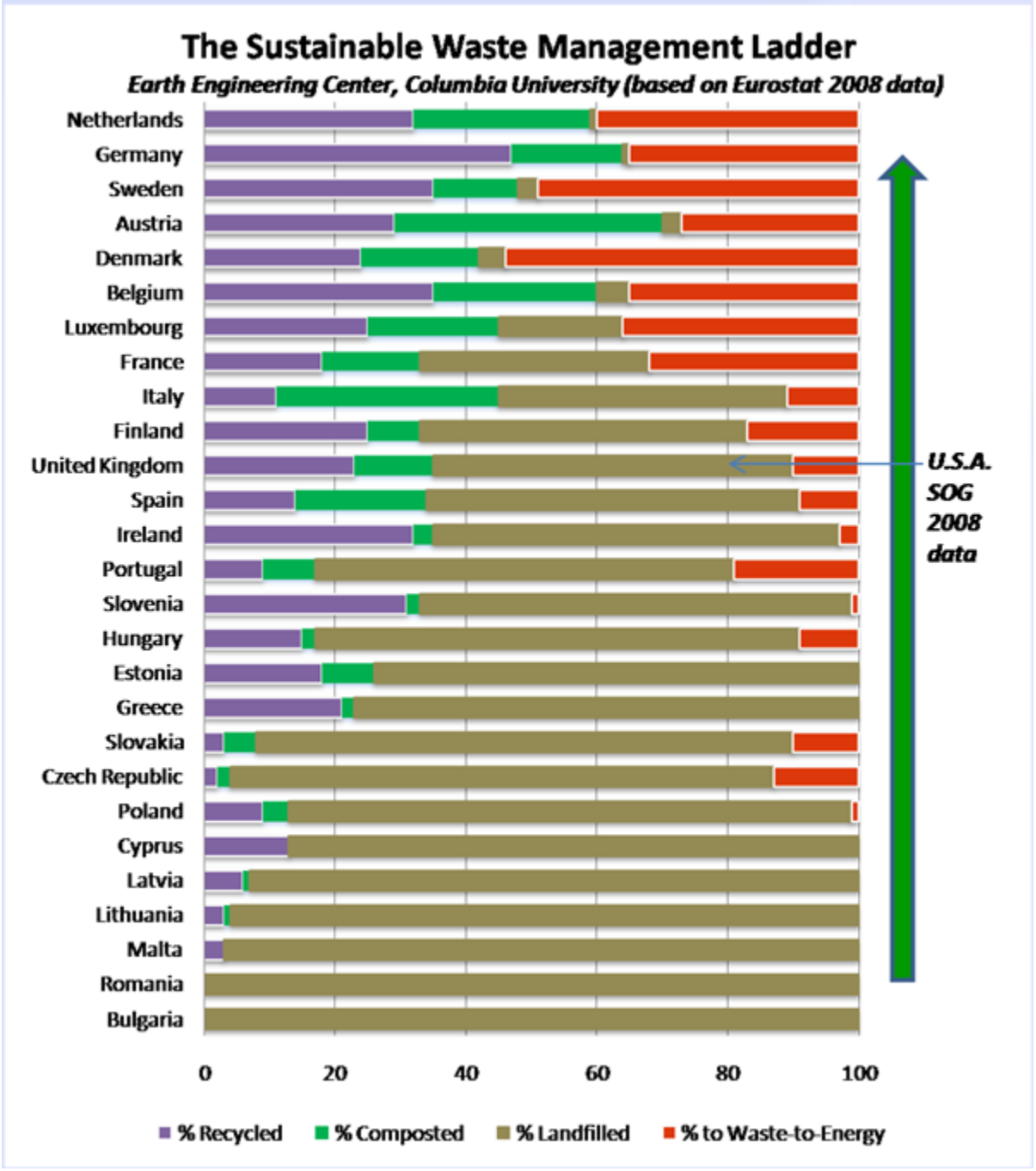
- Federal renewable energy policy and funding
- Local governments desire to be greener and to divert more from landfills
- Local jobs (new construction & operations)
- Increase in disposal fees and transportation costs

..however, there is no disposal crisis in USA!

U.S. WTE Plants

YEAR	WTE/ RDF	Pyrolysis and Gasification	MRF	Recovered (million tons)
2011	71/15	1	565	114.5

Source: Gershman, Brickner & Bratton, Inc. , 2011



Source: Earth Engineering Center, Columbia University, 2009

Locations Advancing "Proven" Technologies

- Mass burn WTE expansions
  - Completed:
    - Hillsborough County, FL - Covanta
    - Lee County, FL – Covanta
    - Olmsted County, MN – Olmsted County
  - Under construction: Honolulu, HI – Covanta
- Mass burn under construction
  - Durham York (Ontario CN) – Covanta
  - Palm Beach County, FL (SWAPBC) – B&W
- Advancing new facilities with 'proven' technologies:
  - Baltimore, MD – Energy Answers
  - Frederick County, MD (NMWDA) - Wheelabrator
  - City of Los Angeles, CA – Green Conversion Systems
  - Puerto Rico – Energy Answers
- Existing facilities being sold/upgraded
  - Harrisburg, PA - Covanta
  - SPSA (Virginia Beach VA area) - Wheelabrator
  - New Hanover County, NC – Covanta selected

Durham/ York (Ontario CN) Covanta

- Design, construction and operation by Covanta
- $260 million financed by Durham and York regions
- 140,000 TPY of waste
- 17.5 MW power and steam
- Recovered ferrous (e.g. steel) and non-ferrous (e.g. aluminum etc.) metals for recycling
- Under construction with target operation date late 2014

New Hanover County, NC - Covanta

- Retrofit and operation of the existing WTE plant
- 500 TPD
- Facility first opened in 1984, and shutdown in April 2011
- 10 MW electrical power (gross)
- Following procurement process, on June 4th, 2012- County Board voted 5:0 to enter into negotiations with Covanta
- GBB is the technical consultant for the County

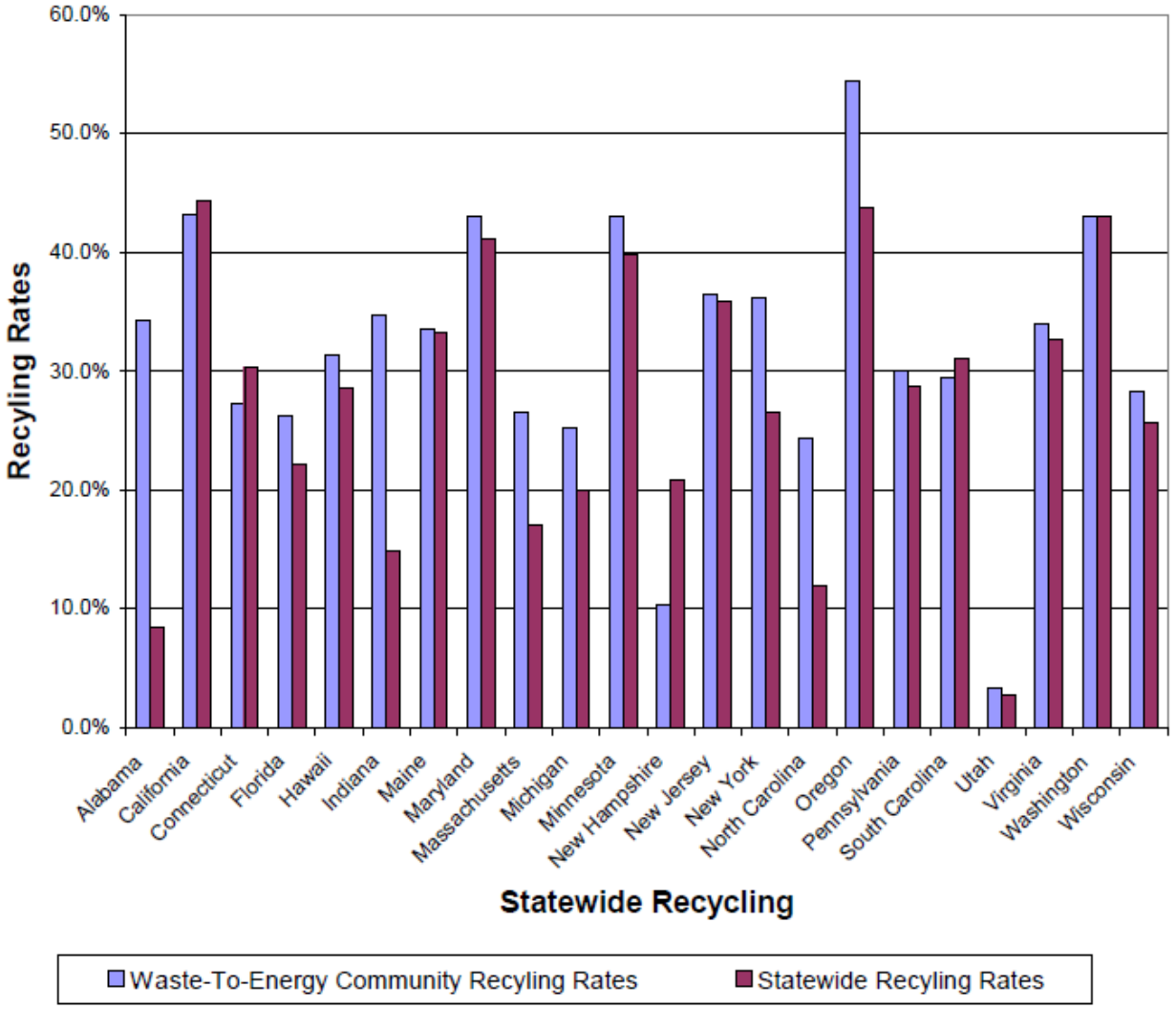
Solid Waste Authority of Palm Beach County, FL

- **Babcock & Wilcox Power Generation Group, Inc.** (B&W PGG), and its partner, **KBR, Inc.** were selected to build the plant
- B&W PGG also to operate and provide maintenance services once the plant is operational

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

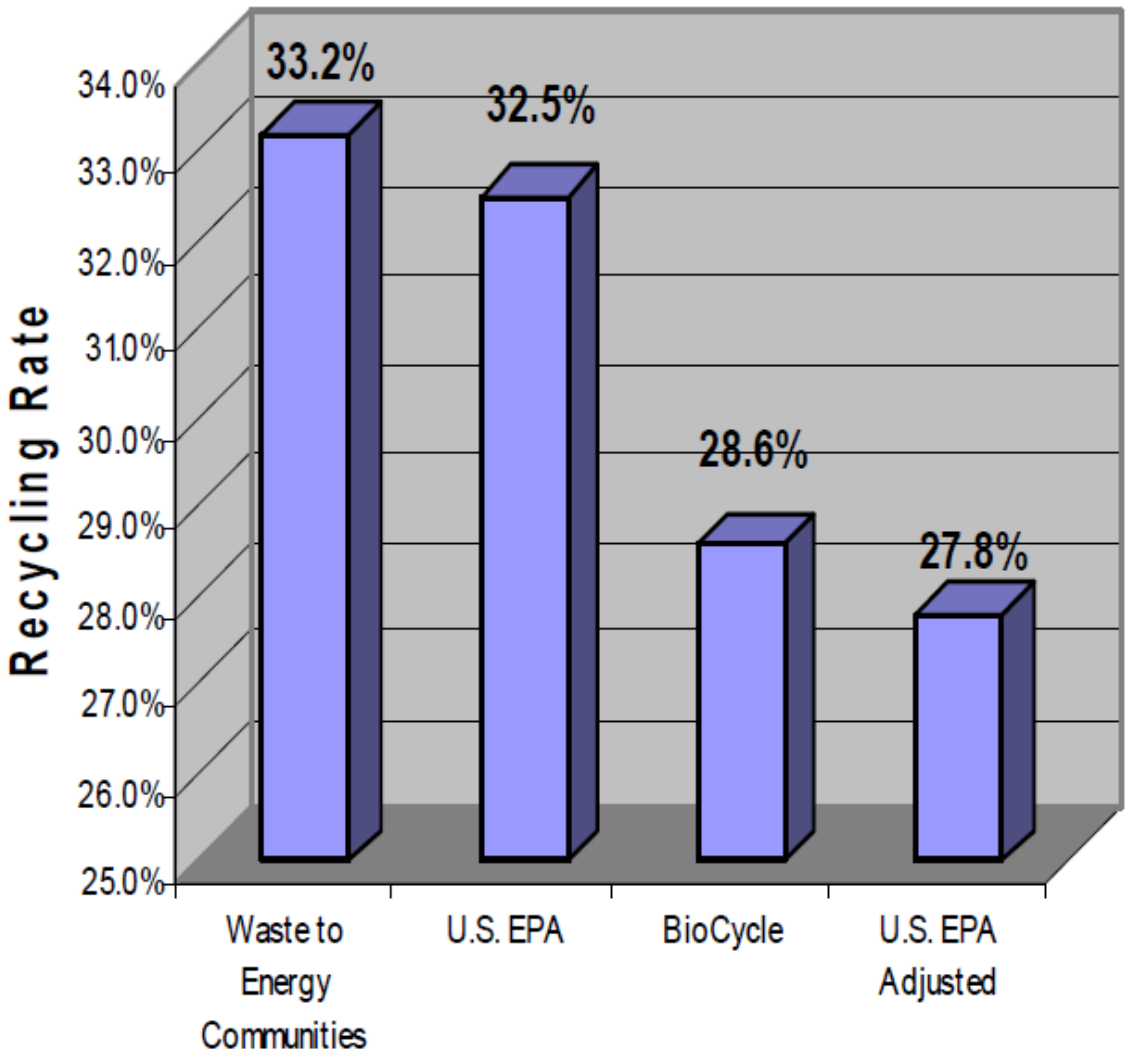
- 3,000 tons per day of MSW capacity -- $668 million construction cost
- 325 full-time construction jobs (900 including all part time), 64 permanent, full-time operation jobs.
- Comments from the Florida Sierra Club and Institute for Local Self Reliance were received suggesting approval to be postponed, alternative waste disposal methods to be studied, especially more recycling.
- GBB hired to review and fact check the accuracy of the statements and claims made by Florida Sierra Club and ILSR
- See: http://www.gbbinc.com/WTE-PB.shtml for 60+ paper
- Authority Governing Board approved awarding contract in April 2011

Recycling Rates: Communities with Waste-to-Energy vs. Statewide Recycling Rates



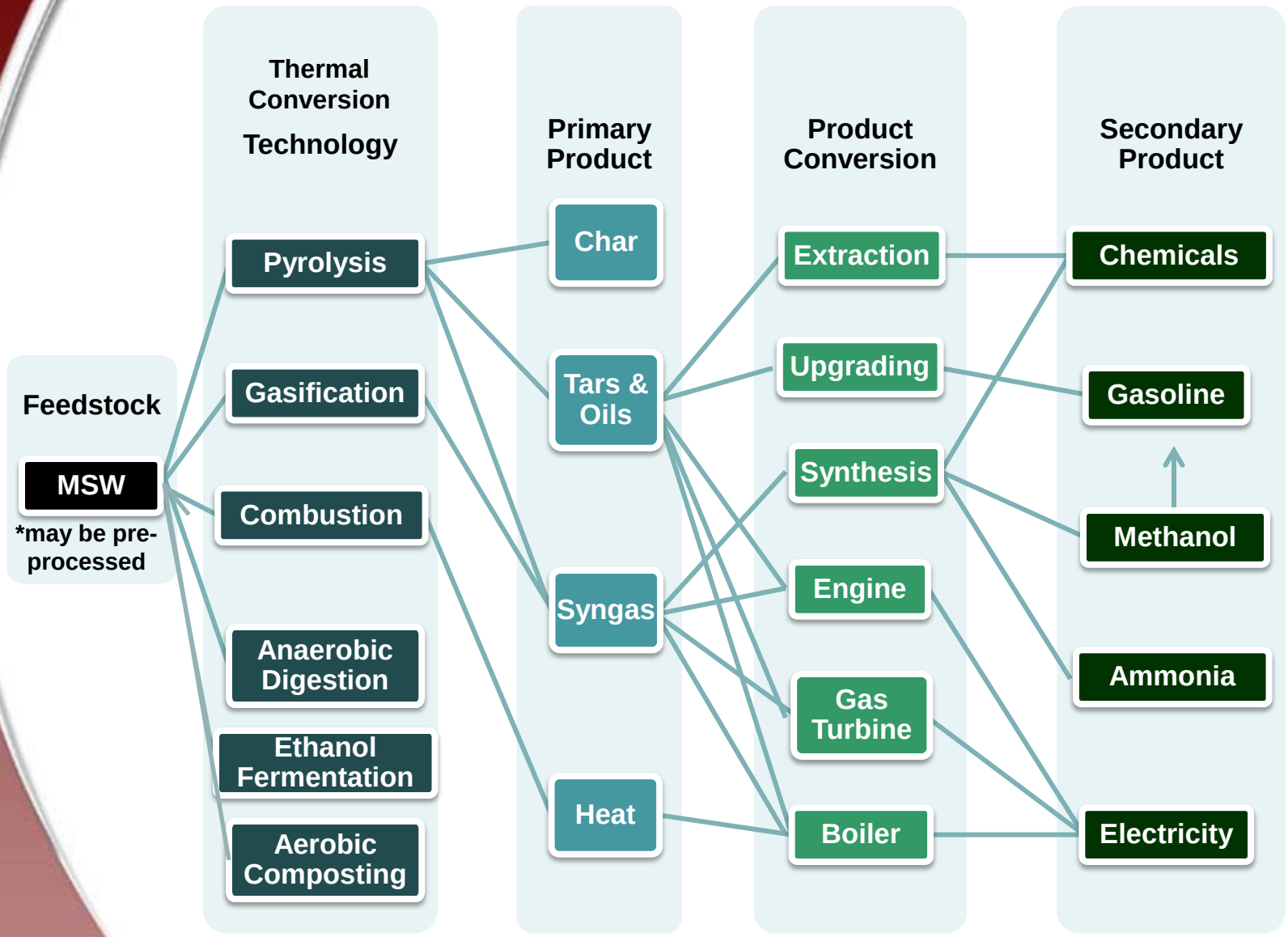
Source: Energy Recovery Council & GAA, 2009

Comparison of Waste to Energy (WTE) Communities' Recycling Rate with National Rates

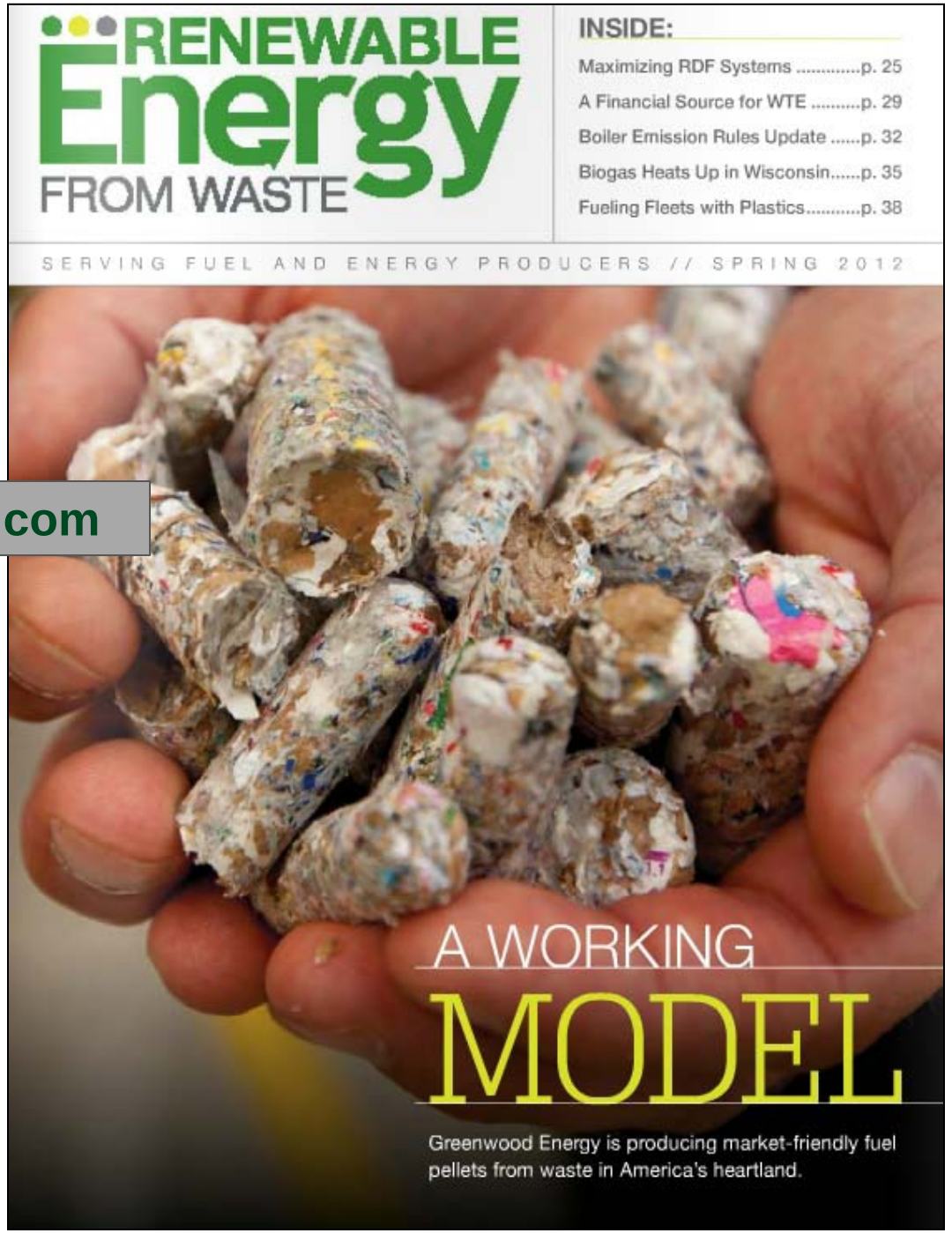


Source: Energy Resource Council and GAA, 2009

Conversion Technology Processes and Products



www.rewmag.com



591 (and counting) Companies Offering Technology and/or Development Services Worldwide

- 34 Aerobic Composting
- 109 Anaerobic Digestion
- 37 Ethanol Fermentation
- 169 Gasification
- 45 Plasma Gasification
- 52 Pyrolysis
- 60 WTE: mass burn, modular, dedicated boilers, and RDF
- 81 Others (agglomeration, autoclave, de-polymerization, thermal cracking, steam reforming, hydrolysis)

Source: Gershman, Brickner & Bratton, Inc., April 2012

150 Conversion Companies Operating either Commercial or Demonstration Facilities Worldwide

- 67 Anaerobic Digestion
- 48 Gasification
- 19 Plasma Gasification
- 16 Pyrolysis

Source: Gershman, Brickner & Bratton, Inc., April 2012

Enerkem

- Gasification followed by catalytic conversion to bio-fuels and chemicals
- Feedstock: MSW, wood chips, treated wood, sludge, petcoke, spent plastics and wheat straw
- Preprocessing- drying, sorting and shredding
- Facilities:
  - Commercial scale demonstration facility in Westbury, CA (since 2009, 1.3 million gallons/year)
  - On going projects on full-scale commercial facilities:
    - Edmonton, Alberta-

      10 mill gallons per year

      under construction, start-up 2013
    - Pontotoc, Mississippi & Varennes, Québec, each 10 million gallons per year are under development (about 200,000 TPY of MSW)

Enerkem's Westbury facility

Fulcrum BioEnergy

- Gasification followed by alcohol synthesis; InEnTec technology partner
- Feedstock: MSW
- Product: ethanol
- Preprocessing required

- Sierra BioFuels- First commercial scale plant under construction in City of McCarran, NV
  - 10.5 million gallons ethanol per year
  - Have local and state regulatory permits
  - Have feedstock contracted through Waste Connections and WM
  - Have off take agreement for full output of plant
  - Estimate completion in 2nd half of 2013
  - Received USDA $105 million loan guarantee in August 2012

INEOS Bio

- Gasification followed by biocatalyst fermentation and distillation
- Feedstock: MSW
- Preprocessing- drying of the feedstock
- Product: Bioethanol

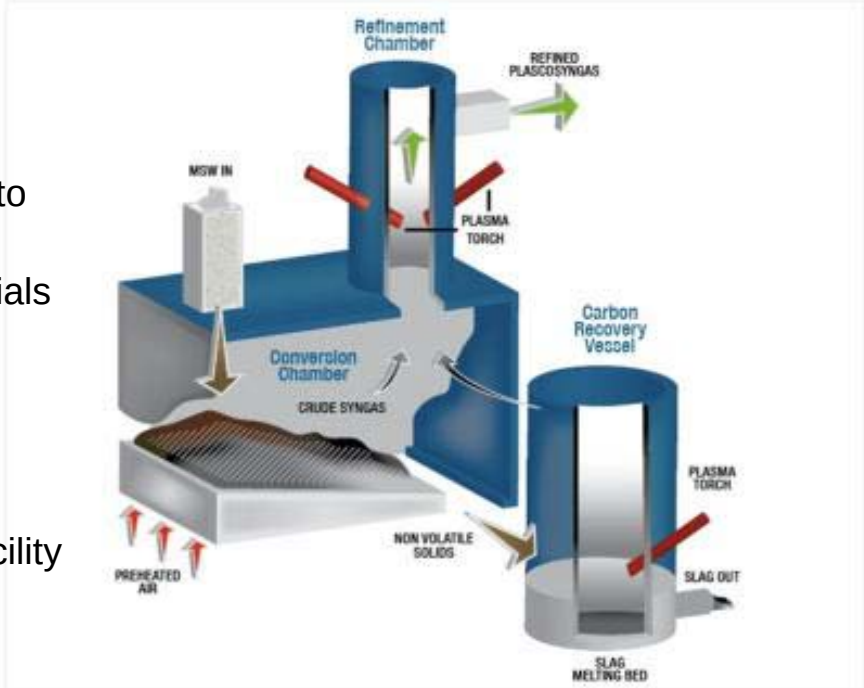
Vero Beach Florida Commercial Facility

Plants:

- Fayetteville, AR- pilot plant
- Vero Beach, Indian River County, FL - under construction
  - process150,000 TPY MSW
  - produce 8 million gallons of fuel-grade ethanol and 6 MW (gross) of electric power
  - start-up and commissioning began in summer 2012
- Lake County (IN) Solid Waste Management District- under development

PlascoEnergy GROUP

- Headquartered in Ottawa, Canada
- Gasification followed by plasma torches to refine the syngas product
- Preprocessing- separation of inert materials
- Plants:
  - Commercial-scale demonstrational, 94 TPD- Train Road, Ottawa, CA
  - R&D, 5TPD,Castellgali, Spain
- Recently contracted to build 375 TPD facility in Ottawa Canada



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Additional Technologies Processing MSW

Company	Technology	Product	Status	Featured plants in N. America	No of commercial plants
coskata	Gasification & Fermentation	Ethanol	demo	Under development: Flagship in Boligee, Alabama (55 mill gallons per year)	1 under construction
Chinook Energy THE END-STAGE RECYCLING COMPANY®	Gasification & metal recovery	SYNGAS and metals	commercial	N/A	>16
ENTECH RENEWABLE ENERGY SOLUTIONS	Gasification	SYNGAS	commercial	Under development: Costa Rica & Huntington Beach, CA	145 >20 on MSW
InEnTec	Plasma gasification	SYNGAS	commercial	Commercial: Columbia Ridge, Arlington, OR, Dow Corning, Midland, MI,	9
TAYLOR BIOMASS ENERGY	gasification	Electricity	Mock-up	Under construction: Town of Montgomery, NY	
THERMOSELECT	Gasification	SYNGAS	commercial	N/A	9

Technologies Processing Mixed Non-recyclable Plastics

Company	Technology	Product	Status	Featured plants in N. America	No . of commercial plants
agilyx	Pyrolysis	Crude oil & combustible gas	demo	Demo: Tigard, OR, 10 TPD	none
CLIMAX GLOBAL ENERGY	Microwave Pyrolysis	Crude wax & combustible gas	demo	Under construction: Blackville, SC 20 TPD	1 under construction
COVANTA / ALPHAKAT	Catalytic Pyrolysis	Diesel Fuel	commercial	R&D at SEMASS WTE, Rochester, MA	5
envion	Far Infrared Pyrolysis	Crude oil & combustible gas	commercial	Demo: Montgomery County, MD, closed 2011	N/A
Plastic2Oil	Catalytic Pyrolysis	Crude oil & combustible gas	Pilot	Pilot: Niagara Falls, NY (45TPD)	none
Re Rational energies	Pyrolysis	Synthetic crude	N/A	Under development: Hennepin County, MN Manatee County, FL	none
VADXX ENERGY	Pyrolysis	Crude oil & combustible gas	Pilot	Pilot: Akron, Ohio	none

Additional Technologies Processing Organic Waste

Company	Technology	Product	Status	Featured plants in N. America	No. of commercial plants
ARROWECOLOGY THE WAY TO ZERO WASTE	Dry anaerobic digestion	Biogas and compost	commercial	Commercial- Sidney , AU Pilot- Hidera, Israel	1
BEKON Energy Technologies GmbH & Co. KG	Dry anaerobic digestion	Biogas and compost	commercial	N/A	14
eci Bio Energy	BTA , wet anaerobic digestion	Biogas and compost	commercial	Toronto, CA Demo: Dufferin Commercial: Newmarket	17
biogas USA entec	Anaerobic digestion	Biogas and compost	commercial	Under development: El Paso, TX	120
HARVEST™ Power of We™	Anaerobic digestion Aerobic composting	Biogas and compost	commercial	Under Construction: London, Ontario 65,000 TPA	6 aerobic composting
TERRABON	Bio-refining	acetic acid, ketones, and alcohols	demo	Demo: Bryan, TX	1 under development

Alternative Energy Subsidies
(Fed'l Grants, Tax Credits & Loan Guarantees)

Year	Value Amount by Fed's
2009	$ 44.3 Billion
2011	$ 30.7 Billion
2012	$ 16.1 Billion
2014	$ 11.0 Billion

Source: Brookings Institute, et.al. Washington DC

Some U.S. Locations Currently Investigating/Advancing Waste Conversion Technologies

- Ada County, ID
- Baton Rouge, LA
- City of Allentown, PA
- City of Cleveland, OH
- City of Dallas, TX
- City of Glendale, CA
- City of Green Bay, WI
- City of Plano, TX
- City of San Antonio, TX
- City of Taunton, MA
- Columbia, SC
- County of Maui, HI
- Fulton, MS
- Gallatin County, KY
- Hennepin County, MN
- Lake County, IN
- Los Angeles County, CA
- New York City, NY
- Prince William County, VA
- Salinas Valley, CA
- San Bernardino County, CA
- Santa Barbara County, CA

Summary of Technologies and Risks/Liabilities

Source: Gershman, Brickner & Bratton, Inc. August 2012

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 to Low
Anaerobic Digestion	Proven technology; limited U.S. commercial experience	Moderate to Low
Mixed-Waste Composting	Previous large failures; No large-scale commercially viable plants in operation; subject to scale-up issues	Moderate to high
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
Chemical Decomposition/ Depolymerization	Technology under development; not a commercial option at this time	High

WM's Organic Growth Group
(Investments in Alternative Conversion Technologies)

- Terrabon
- Renmatix
- Genomatica
- Fulcrum Bioenergy (1)
- Enerkem (1)
- Agilyx
- Agnion
- InEntec

(1) Nearest to Fuels Commercialization

Big News This Week!!

- Terrabon filed Chapter 7 Bankruptcy
- Was to have 2012 financing round – WM expected lead...but backed out!
- Founded in 1995 - but no engineering package yet for commercial scale
  - Goal – 70 gallons “green gasoline” / ton MSW
  - In 2009, Terrabon believed its 200+ tpd plant could produce 5.5 million GPY of renewable gasoline for approx. $1.75 to $2.00 per gallon.
  - Now -1000 tpd(dry) [e.g.1400 tpd @30% H2O]

    Projected: $4.00 - $5.33 / Gallon as Capital Cost & $0.67 / Gallon Operating Cost

Opinion of Trends for the Future...

- New technologies will need 3-5 years to learn if they work and their economics (time for permitting, financing, construction and initial operating)
- Potential for added economic benefits: placing value on carbon credits and power from waste as ‘renewable energy’
- ‘Environmentalists’ and ‘Zero Waste’ proponents will continue to fight WTE and Waste Conversion Technologies calling them all “incineration”
- Continuation of public sector taking “Low Risk” attitude until conversion technologies and companies more proven

Project Building Blocks

- Limited and High Alternative Disposal Costs
- Waste Supply
- Energy and Materials Market(s)
- 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 with resources and proven technology or willingness to take technology risk
- Capital
- Financeability
- Compatibility with High Level of Recycling
- Political Will

A Realistic & Ultimate Goal:

Fully Integrated and Efficient Waste Management System with Significant Diversion (Recycling) and WTE-WCT

…in a 50-50 partnership!

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

Thank you!!

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