Waste-to-Energy and Conversion Technologies Under The Commercial Microscope

2nd Annual Waste Conversion Congress East Coast
Philadelphia, PA
June 12-13, 2012

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

Outline*

- Introduction
- Selected Waste Conversion Technology companies and their projects
  - Technologies processing MSW
  - Technologies processing mixed non-recyclable plastics
  - Technologies processing organic waste
- Ongoing and future project developments
- Summary and Trends for Future
- Q&A

*Research support from Ljupka Arsova and Elizabeth Rice

2

Intro - 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 and focused exclusively to solid waste management
- Owner's representative and feasibility reports for financings
- "Change Agents" to produce better services and facilities

3

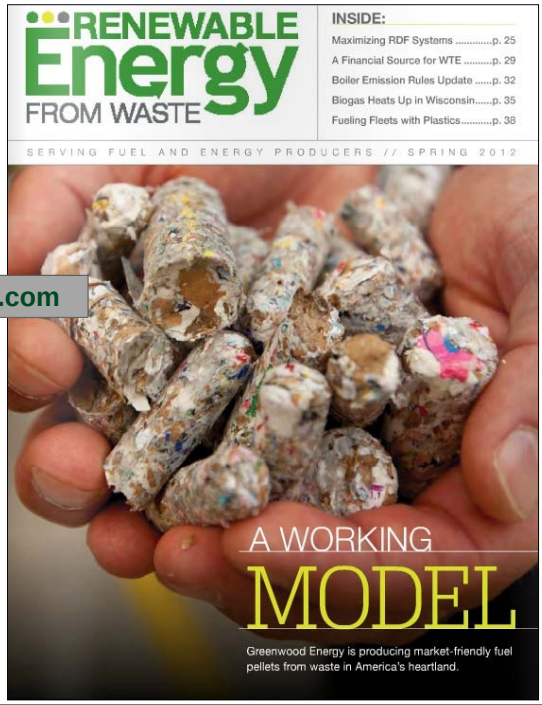
GBB Waste to Energy and Conversion Technology Services

- 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 business planning for private companies considering purchasing technologies or investing in projects
- Waste characterization and sourcing; processing conceptual design and cost estimating
- Independent feasibility consultant

4

Renewable Waste INTELLIGENCE

www.rewmag.com



GBB SOLID WASTE MANAGEMENT CONSULTANTS

5

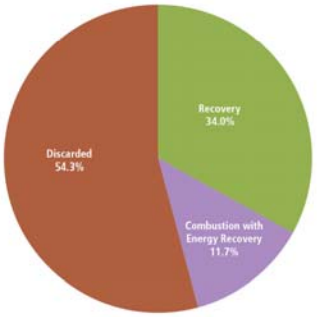
Renewable Waste INTELLIGENCE

Introduction

GBB SOLID WASTE MANAGEMENT CONSULTANTS

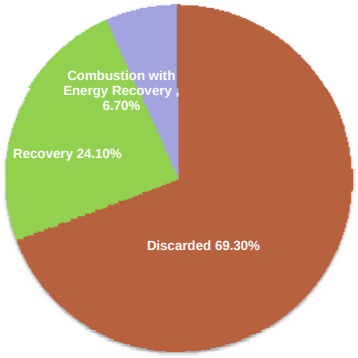
6

MSW Management in the U.S.



EPA Estimate: 250 million tons

2010

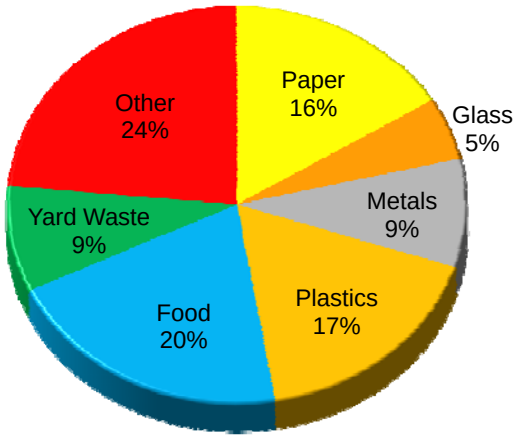


Biocycle Estimate: 389 million tons

2008

7

U.S. MSW Characterization (post recycling)



Source: USEPA, Municipal Solid Waste Generation, Recycling, and Disposal in the United States, 2011

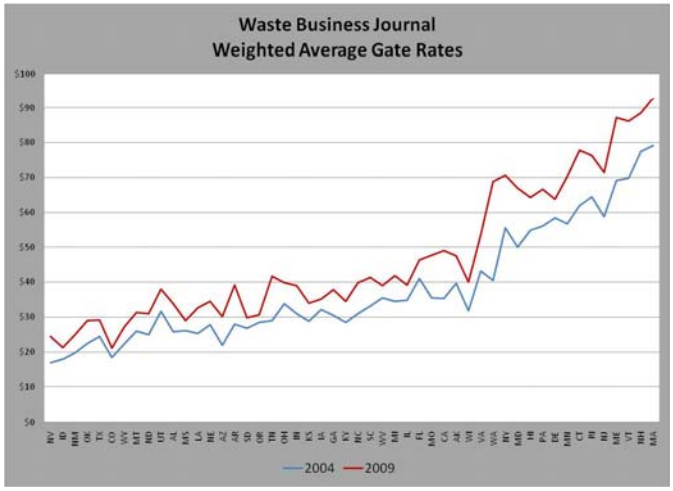
8

Factors Contributing to Increased Interest in WTE and CTs

- Federal renewable energy policy and funding
- Local governments desire to be greener and to divert more from landfills
- Local jobs
- There is no disposal crisis
- Increase in disposal fees and transportation costs

9

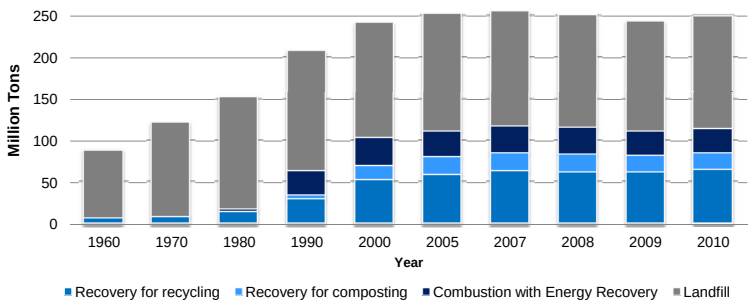
Landfill Gate Rates per Ton in the U.S. 2009 Compared to 2004



Source: Waste Business Journal: www.wastebusinessjournal.com

10

Capacity for Growth



The total installed US WTE capacity in 2010 was 2.7 GW, combusting only 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

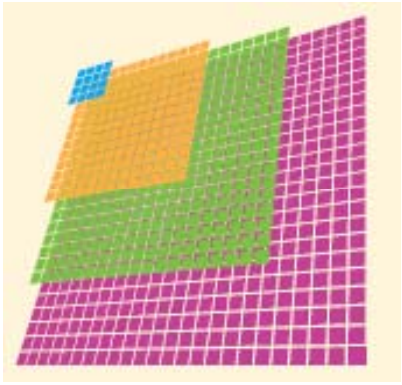
Source: USEPA, 2010

11

Renewable Energy Technology Land Use

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

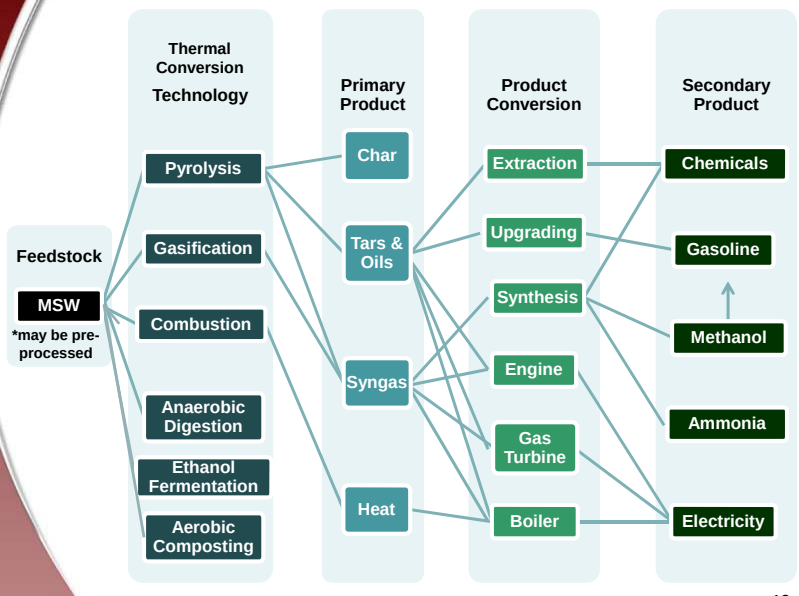
- WTE facilities require an average of 0.7 acres/MW
- Landfill gas requires 27 acres/MW
- Solar requires 8 acres/MW
- Wind requires 18 acres/MW



Source: Covanta Energy, 2012

12

Conversion Technology Processes and Products



13

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

14

150 Conversion Companies Operating either Commercial or Demonstration Facilities with MSW Worldwide

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

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

15

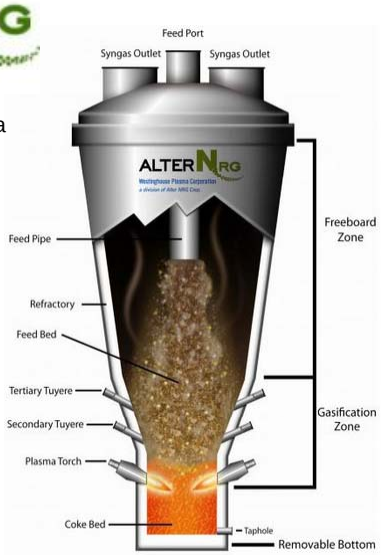
Technologies Processing Mixed MSW

16

Renewable Waste INTELLIGENCE

ALTERNRG

- Plasma gasification- developed in partnership with Westinghouse Plasma Corp.
- Feedstock: different including auto shredder residue, plastics, biomass, wood waste
- Product; SYNGAS for power generation or further conversion to ethanol
- Preprocessing NOT required
- Plants:
  - Demonstration facility in Madison, PA, 48 TPD
  - Commercial in Japan, Canada, India, and the U.S.
  - Under development in 11 countries through partnerships with Coskata, SMSIL, NRG Energy
  - St. Lucie County, FL terminated Geoplasma project 4/17/12



AlterNRG gasifier

GBB SOLID WASTE MANAGEMENT CONSULTANTS

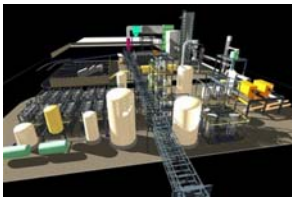
17

Renewable Waste INTELLIGENCE

BlueFire ETHANOL

BlueFire Ethanol

- Concentrated Acid Hydrolysis Process
- Feedstock: post-recycled MSW, rice and wheat straws, wood waste and other agricultural residues
- Product: ethanol, and other viable alternatives to petroleum derived fuels
- Preprocessing required- shredding and drying of the feedstock



Fulton, MS site prepared for construction, June 2011

- Plants under development:
  - Lancaster, CA – 3.7 million gallon per year, feedstock post-sorted MSW
  - Mecca, CA –17 million gallon per year, feedstock post-sorted MSW and wood waste
  - Fulton, MS – 19 million gallon per year, feedstock: woody biomass and mill wastes

GBB SOLID WASTE MANAGEMENT CONSULTANTS

18

Chinook Energy, LLC

- Gasification and pyrolysis
- Feedstock: mixed waste
- Product: syngas and that can be used for energy generation or fuel production
- Plants:
  - 15 commercial gasification plants processing scrap material for metal recovery
  - Several commercial under development in the US and UK

19

Enerkem

- Gasification followed by catalytic conversion to bio-fuels and chemicals
- Product: ethanol (100 gallons/ton of waste)
- 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)
  - Pilot plant in Sherbrooke, CA (since 2003, used to test over 25 different solid, slurried, and liquid feedstock)
  - On going projects on full-scale commercial facilities:
    - Edmonton, Alberta- 10 mill gallons per year under construction, start-up 2013
    - Pontotoc, Mississippi and Varennes, Québec, each 10 million gallons per year under development

Enerkem's Westbury facility

20

Fulcrum BioEnergy

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

- Sierra BioFuels- first commercial 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 offtake agreement for full output of plant
  - Estimate completion in 2nd half of 2013

Fulcrum claims to have secured enough MSW feedstock to produce more than 700 million gallons of biofuels at facilities to be located across the US

(source: http://www.fulcrum-bioenergy.com/future.html)

21

Fiberight

- Ethanol fermentation
- Feedstock- MSW
- Preprocessing- separation, cleaning and preparation of the organic fraction of the MSW
- Plants:
  - Pilot plant in Lawrenceville, VA- in partnership with Novozymes robust enzyme catalysts and enzyme recycle process developed
  - Blairstown, IA- 6 million gallons per year, commenced production at corn ethanol converted, expected to be fully operational in the first half of 2013.
  - Has site control for commercial-scale biofuel plant in Elkridge, MD
- In 20-year partnership with TMO Renewables, UK, to build fifteen bio-refinery plants across the US in the next five years

Fiberight High-Solids Pulping

novozymes Rethink Tomorrow

TMO Blairstown, Iowa Layout

22

Renewable Waste INTELLIGENCE

INEOS Bio

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

Pilot facility in Fayetteville, AR

Plants:

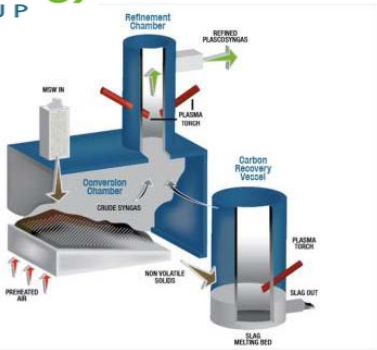
- Fayetteville, AR- pilot plant
- Vero Beach, Indian River County, FL
  - process 150,000 TPY MSW
  - produce 8 million gallons of fuel-grade ethanol and 6 MW (gross) of electric power
  - construction completed and is about to start operating
- Lake County (IN) Solid Waste Management District- under development by Powers Energy of America, currently experiencing difficulties securing financing

GBB SOLID WASTE MANAGEMENT CONSULTANTS

23

Renewable Waste INTELLIGENCE

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
- Selected by the Salinas Valley Solid Waste Authority (CA) as a viable technology for planned Resource Management Park, Environmental Impact Study currently underway
- Shortlisted in Santa Barbara, CA
- Other plans to build facilities in Canada and China

GBB SOLID WASTE MANAGEMENT CONSULTANTS

24

Additional Technologies Processing MSW and Industrial Waste

Company	Technology	Product	Status	Featured plants in N. America	No of commercial plants (on all feedstocks)
coskata	Gasification & Fermentation	Ethanol	demo	Under development: Flagship in Boligee, Alabama (55 mill gallons per year)	1 under construction
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

25

Technologies Processing Organic Wastes

26

CR&R Inc. – Perris, CA

- Selected as one of four Los Angeles County alternative technology projects
- 150 TPD from CR&R dirty-MRF, post-recycled residual output to DRANCO 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
- Construction is expected to commence in 2012 and be completed in 2014

DRANCO

- Dry anaerobic digestion technology developed in Belgium
- 5 demonstrational and 25 commercial plants worldwide
- Feedstock: organic fraction of the MSW, dewatered sewage sludge, biowaste and other source-separated organic waste streams

Organic Waste Systems

Dranco AD plant in Hotaka, Japan

27

W2e Organic Power

- Wet anaerobic digestion technology
- Pre-processing required
- Teamed with CIYCOR and Eisenmann
- Plants:
  - Columbia, SC- commercial scale prototype under construction
    - 48,000 TPY; 3.2 MW power
    - Process organics from households and businesses
    - Start-up expected 2012
  - Gastonia, NC & Baton Rouge, LA- planned for future

EISENMANN

W2e Organic Power

28

Zero Waste Energy LLC

ZeroWaste ENERGY, LLC. Recovery and Energy with Zero Waste

- Dry anaerobic digestion Kompoferm system
- Products: biogas and compost
- Plants:
  - Demonstration plant: San Jose, CA
  - Commercial plant under construction: San Jose, CA- 270,000 TPY expected to start operating in April 2013
  - Commercial plants under development:
    - Santa Paula, CA- 15,000 TPY
    - Monterey Regional Waste Management Authority, CA- 5,000 TPY
    - Napa, CA- 20,000 TPY
    - South San Francisco, CA- 9,000 TPY

29

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	Dry anaerobic digestion	Biogas and compost	commercial	N/A	14
eci Bio Energy	BTA , wet anaerobic digestion	Biogas and compost	commercial	Under construction: 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- 700 TPD	1 under development

30

Technologies Processing Mixed Non-Recycled Plastics

31

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, Under development: Hennepin County, MN Manatee County, FL	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
VADXX ENERGY	Pyrolysis	Crude oil & combustible gas	Pilot	Pilot: Akron, Ohio	none

32

Ongoing and Future Project Developments

33

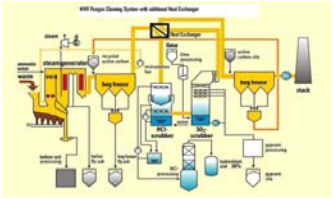
Locations Advancing "Proven" Technologies

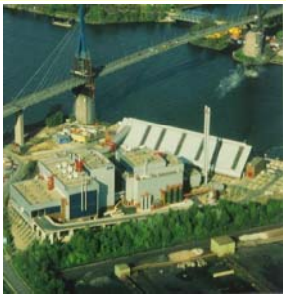
- Mass burn WTE expansions
  - Completed:
    - Hillsborough County, FL – Covanta (from 1,200 to 1,800 TPD)
    - Lee County, FL – Covanta (from 1,200 to 1,860 TPD)
    - Olmsted County, MN – Olmsted County (from 200 to 400 TPD)
  - Under construction: Honolulu, HI – Covanta (new 900 TPD unit)
- Advancing new facilities with 'proven' technologies:
  - Baltimore, MD – Energy Answers
  - Frederick County, MD (NMWDA) - Wheelabrator
  - Durham York (Ontario CN) - Covanta
  - City of Los Angeles, CA – Green Conversion Systems
  - Palm Beach County, FL (SWAPBC) – B&W (under construction)
  - Puerto Rico – Energy Answers
  - Vancouver, British Columbia, CA
- Existing facilities being sold/upgraded:
  - Harrisburg, PA
  - New Hanover County, NC

34

City of Los Angeles, CA – Green Conversion Systems

- 365,000 TPY post-recycled residential waste
- "Advanced Thermal Recycling" system 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





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

35

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

36

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
- 10MW electrical power
- Following procurement process, on June 4th, 2012- New Hanover County Board of Conditioners voted 5:0 to enter into negotiations with Covanta
- GBB is the technical consultant for the County

37

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 in April 2011.
- B&W PGG to operate and provide maintenance services once the plant is operational

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

- $668 million construction cost
- 3,000 tons per day of MSW capacity
- 325 full-time construction jobs (900 including all part time), 64 permanent, full-time operation jobs.

- 2009
  - Authority two-stage contractor procurement included due diligence review of new technology offerings
  - GBB hired to review potential alternative technologies and present its findings to Authority Governing Board
  - Authority authorized to continue its two-stage procurement process with mass burn technology

38

Solid Waste Authority of Palm Beach County, FL (Cont'd)

- 2011
  - Authority received competitive proposals and made selection recommendation to the Authority Governing Board
  - 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 again hired to review and fact check the accuracy of the statements and claims made by Florida Sierra Club and ILSR
    - Summary of GBB analysis:
      - WTE is fully compatible with recycling and integral to well-managed solid waste systems
      - WTE reduces GHG emissions
      - Management and financial difficulties were contributing factors to WTE plants that have issues; the issues were not operational issues
      - Resurgence of interest in WTE technologies
      - Solid waste systems cost money
- See: http://www.gbbinc.com/WTE-PB.shtml for white papers
- Authority Governing Board approves awarding contract in April 2011
- **GROUNDBREAKING CEREMONY was APRIL 4, 2012!**

39

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 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

40

Prince William County, Virginia

- County wants to create the Prince William Renewable Energy Park (PWREP) at the landfill (currently receiving 875 TPD MSW)
- County seeking to host a waste conversion technology demonstration facility on the County's landfill or composting sites
- Issuing RFP to identify qualified technology companies to design, build, finance, own and operate their demonstration
- Looking for technologies proven at throughputs of 50 to 200 TPD on a continuous basis
- Eligible technologies include pyrolysis, gasification, anaerobic digestion, plasma torch or other conversion method producing a fuel or energy product, such as electricity, syngas, steam, useable heat and/or other industrial outputs
- Check status on the County's e-procurement web page under solicitations: https://www2.pwcgov.org/e-proc/default.asp

41

City of Philadelphia, PA

- 1.6 to 1.8 million tons of waste in the City
- Collection/management:
  - 40% by City, primarily residential
  - 60% by private haulers
- Recycling: Commercial - 50% and City -18% in 2010
- City collects and manages 600,000 TPY
  - 6 transfer and disposal sites, only one is city owned
    - 55% to mass burn WTE
    - 45% to landfill
  - Blended cost: $66 per ton
- New MWPF by Waste Management and Covanta 4 Recovery awarded to produce RDF pellets and recyclables from 143,000 TPY
  - RDF to displace coal use at existing chemical, cement kiln, and electric generation facilities

42

Summary and Trends for Future

43

Technologies and Risk

Source: Gershman, Brickner & Bratton, Inc. March 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
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
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

44

Opinion of Trends for the Future...

- New technologies will need 4-6 years to learn if they work and what their economics will be
- Will there be added economic value for carbon credits and power from waste as 'renewable energy'?
- Renewable fuel standards from EPA and added recycling requirements (e.g. for RIN generation in ethanol production) – will they change?

45

Opinion of Trends for Future (Cont'd)

- Public sector taking "Low Risk" attitude until conversion technologies and companies more proven
- Continued recycling industry demand for more paper, aluminum, and plastics
- More mixed waste processing
  - Added recycling side-benefit
  - Most conversion technologies require pre-processing for feedstock preparation
  - Electric utilities and other solid fuel users may become interested in RDF
- 'Environmentalists' and 'Zero Waste' proponents will continue to fight WTE and Waste Conversion Technologies calling them all "incineration"

46

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!

47

Thank you!!

Harvey Gershman
HGershman@gbbinc.com
1-703-573-5800
www.gbbinc.com

48