Waste as a Fuel for CHP Opportunities and Technologies

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By
Harvey W. Gershman, President
Gershman, Brickner & Bratton, Inc.
Fairfax, VA
With Research Support from
Neil Daniel and Thomas Reardon

GBB Overview

Celebrating our 30th Anniversary

- 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

2

Waste Management Overview

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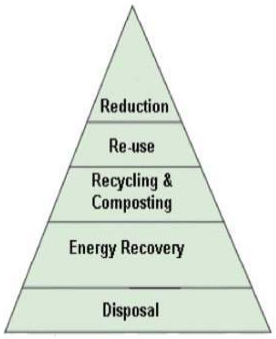
3

EPA's Waste Management Hierarchy Policy

- (Previous) Waste Management Hierarchy
  - Source Reduction
  - Recycling
  - Landfill and Incineration
- (Current) Waste Management Hierarchy, as of 2005
  - Source Reduction
  - Recycling (35% goal)
  - **Incineration/Thermal Processing with energy recovery (defined as renewable)**
  - Landfilling/Incineration without energy recovery



Source: U.S. EPA, 2009

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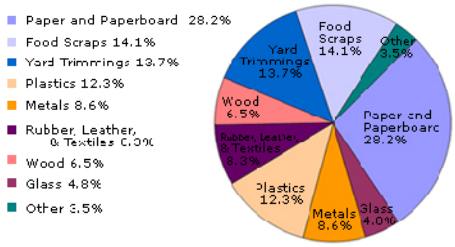
4

Waste Facts

Total MSW Generation (by Material), 2009
243 Million Tons (Before Recycling)



- Each person in U.S. today generates 4.34 lbs. per day
- What is in our waste?
  - Recyclables
    - Feasible now to recycle up to 50-60%
  - Energy content of remainder: 5,500 BTUs per pound
    - Coal at 9,000 BTUs per pound

Source: US EPA, 2009 data

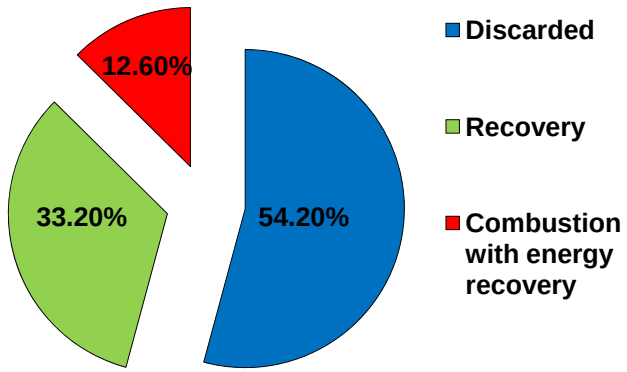
5

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

6

MSW Disposal in America



Source: USEPA 2008

7

86 U.S. WTE Plants - $14 Billion is 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: Energy Recovery Council, 2010 Directory

8

Now - 2011

- Several WTE expansions/new projects being undertaken (some 5-7)
- Over 400 different companies offering alternative conversion technologies
- Some local governments pursuing proven and/or alternative conversion technologies (some 10-15)
- USDOE and USDA loan/grants supporting several alternative conversion technologies (some 4-6)
- U.S. wants to reduce dependence on foreign oil and reduce greenhouse gases and carbon emissions
- U.S. needs more clean and renewable energy
- Additional Federal legislative incentives 'firmly up in the air'
- Some incentives supporting brownfield development for CHP and renewable energy, including from biomass and MSW

ARROWECOLOGY THE WAY TO ZERO WASTE
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INTERSTATE WASTE TECHNOLOGIES
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Wheelabrator Technologies Inc. A Waste Management Company

9

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
- Low risk assumption by public sector until new technologies proven
- Continued demand for recyclables; industry wants more paper, aluminum, and plastics
- 'Environmentalists' and 'Zero Waste' proponents will continue to fight WTE and alternative technologies calling them all "incineration"

10

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

Baseline Description	Alternative	Total GHG Emissions (MTCO2E/day) from:			
		Baseline MSW Generation and Management	Alternative MSW Generation and Management	GHG Emission or Reduction Difference	Barrels of Oil Saved (bbls/day)
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.

11

WTE Facilities providing Steam and Electricity

12

Nashville, TN
District Energy

1974 - 2003

2003 - present

- Thermal provided DH&C services to almost 40 buildings for 30-years …from 1974-2003
- Since its inauguration in December 2003, Metro Nashville DES has received several awards:
  - 2006 IDEA Public Sector Leadership Award
  - 2006 IDEA System-of-the-Year Award
  - 2005 Public-Private Partnership Award
  - 2005 Grand Award for Engineering Excellence
  - 2003 IDEA Gold Award
  - 2003 IDEA Silver Award

13

Nashville District Energy System
2002 Customers and Demand

Building Ownership/Name/Services	Building Sq. Ft.	Steam (lbs./hr.)	Contract Demand Chilled Water (tons)
State of Tennessee			
Andrew Jackson Building (S) (C/W)	545,000	83,000	1,784
James J. Polk Building (S) (C/W)	758,000	12,000	1,500
Central Service Building (S) (C/W)	90,000	Included in Andrew Jackson Bldg. (AJB)	400
Cordell Hull Building (S) (C/W)	358,000	Included in AJB	1,000
Library & Archive Building (S) (C/W)	80,000	Included in AJB	150
State Capitol Building (S) (C/W)	66,000	Included in AJB	200
Supreme Court Building (S) (C/W)	40,000	Included in AJB	125
War Memorial Building (S) (C/W)	316,242	Included in AJB	550
Tennessee State University Building (S) (C/W)		Included in AJB	Included in AJB
Legislative Plaza Building (S) (C/W)		Included in AJB	Included in AJB
John Sevier Building (S) (C/W)		Included in AJB	Included in AJB
Rachel Jackson Building (S) (C/W)		Included in AJB	Included in AJB
Citizens Plaza Building (S) (C/W)	295,115	4,600	700
Tennessee Tower (S) (C/W) (I)	850,000	25,200	1,500
Total State Customers	**3,398,357**	**124,800**	**7,909**
Metro Buildings			
Court House (S) (C/W)	239,616	8,000	500
*Stahlman Building (S) (C/W)	157,000	4,425	500
Criminal Justice Building (CJB) (S) (C/W)	386,000	14,710	645
Safety Building (S) (C/W)		Included in CJB	Included in CJB
Municipal Auditorium (S) (C/W)	142,000	14,000	1,100
Convention Center (S) (C/W)	650,000	18,750	1,400
Nashville Arena (S) (C/W)	529,341	24,150	2,835
The Coliseum	N/a	0	2,000
Total Metro Customers	**2,103,957**	**84,035**	**8,980**
Private Buildings			
*Washington Square (S) (C/W)	288,000	4,300	500
Parkway Towers (S) (C/W)	215,000	8,000	550
Union Planters Bank (S) (C/W)	75,000	3,000	250
Sheraton Hotel (S) (C/W)	476,000	15,000	860
South Trust Bank (S) (C/W)	82,000	2,000	190
**Public Square Parking (S) (C/W)	36,700	1,500	110
Hermitage Suites Hotel (S) (C/W)	80,000	4,000	300
501 Building (S) (C/W) (I)	86,000	2,500	250
**Sun Trust Bank (S) (C/W)	301,200	18,200	765
Sun Trust Center (S) (C/W)	490,000	0	900
Renaissance Hotel (S) (C/W)	650,000	21,250	1,000
The Tower (C/W)	100,000	0	600
Included in Convention Center)			
City Centre (C/W)	420,000	0	1,600
St. Mary's Church (S) (C/W)	13,200	490	40
Ryman Auditorium (S) (C/W)	35,860	2,587	294
Wild Horse Saloon (S) (C/W)	52,091	2,800	270
Total Private Customers	**3,401.05**	**85,627**	**8,479**
Consolidation:			
Total State Customers	3,398,357	124,800	7,909
Total Metro Customers	2,103,957	84,035	8,980
Total Private Customers	3,401,051	85,627	8,479
Total	**8,903,365**	**294,462**	**23,368**

14

Wheelabrator Baltimore, L.P.
Baltimore, Maryland

- Commercial Operation: 1985
- Energy-from-Waste System: Three 750-ton-per-day mass burn units with waterwall furnaces and Von Roll reciprocating grates.
- Steam flow to turbine: 510,000 pounds per hour @ 850 psig/825°F
- Air Pollution Control Equipment: Dry scrubbers, electrostatic percipitators, SNCR (NOx controls), carbon injection
- Rated Refuse Capacity: 2,250 tons per day
- Energy Generation @ Rated Capacity: 60 megawatts from one condensing steam turbine generator
- Electricity sold to: Baltimore Gas & Electric Company
- Steam sold to: Trigen Baltimore Corporation for the downtown heating and cooling loop that provides services Baltimore retail and commercial buildings; has the capacity to supply Trigen with up to 220,000 pounds of steam per hour (more than 40 percent of Trigen's steam requirements)

15

COVANTA Hennepin Energy Resource Co., L.P.
Minneapolis, Minnesota

- Site: 15 acres in downtown Minneapolis
- Commercial Operation: October 1989 (Covanta Energy acquired the facility in 1991 from the Blount Energy Resource Corp.)
- Energy-from-Waste System: Two 606-ton-per-day mass burn units with waterwall furnaces and W + E Umwelttechnik A.G. stokers and ash handling systems
- Boiler Design: 630 psig/752°F superheater outlet conditions
- Air Pollution Control Equipment: Semi-dry flue gas scrubbers injecting lime, fabric filter baghouses, nitrogen oxide control system, mercury control system, and continuous emissions monitoring (CEM) system
- Rated Refuse Capacity: 1,212 tons per day
- Energy Generation @ Rated Capacity: Up to 39.6 megawatts from one condensing steam turbine generator
- Steam Sold to Xcel Energy Co.: 10,000 to 50,000 lbs of steam per hour sent to Excel's Hennepin Energy Center (downtown)

16

COVANTA Indianapolis, Inc.
Indianapolis, Indiana

- Site: 21 acres in Indianapolis, IN
- Commercial Operation Date: December 1988
- Energy-from-Waste System: Three 725 ton-per-day waterwall furnaces with Martin® reverse-reciprocating grates and ash handling system
- Boiler Design: 510 psig/710°F superheater outlet condition
- Air Pollution Control Equipment: Semi-dry flue gas scrubbers injecting lime, fabric filter baghouses, nitrogen oxide control system, mercury control system, and continuous emissions monitoring (CEM) system
- Rated Refuse Capacity: 2,175 tons per day/MSW
- Steam Export Capacity to Citizens Thermal Energy: no less than 4,500 lbs./steam per ton (587,400 lbs of steam per hour)

17

COVANTA Kent, Inc.
Grand Rapids, Michigan

- Site: 9.86 acres
- Commercial Operation: January 1990
- Energy-from-Waste System: Two 312.5-ton-per-day waterwall furnaces with Martin® reverse-reciprocating grates and ash handling system
- Boiler Design: 865 psig/830°F superheater outlet conditions
- Air Pollution Control Equipment: Semi-dry flue gas scrubbers injecting lime, fabric filter baghouses, nitrogen oxide control system, mercury control system, and continuous emissions monitoring (CEM) system
- Rated Refuse Capacity: 625 tons per day
- Energy Generation @ Rated Capacity: up to 18 megawatts from one condensing steam turbine generator with a controlled extraction and/or up to 116,000 lbs/hr of exported steam
- Electricity sold to Consumers Power Company
- Steam sold to Kent County District Heating and Cooling Operation

18

DISTRICT ENERGY ST. PAUL™

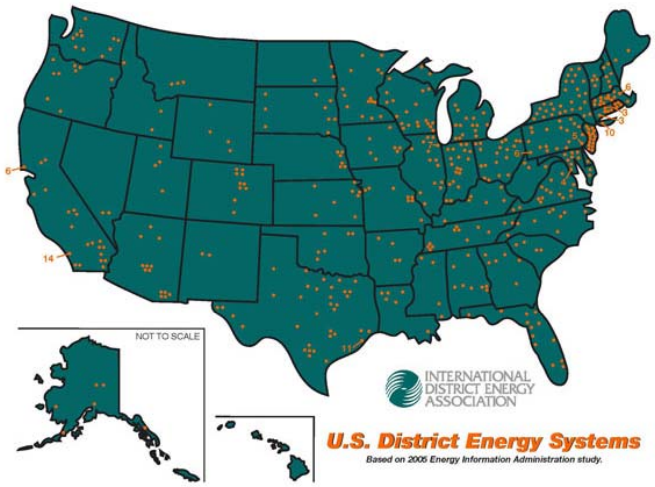
- Operates the largest, most successful, biomass-fueled hot water district heating system in North America
- Numerous local, national and international awards and honors
- Uses wood chips (biomass), natural gas, oil or clean-burning coal to fuel its district heating and cooling systems
- Steam service:
  - Signed customer buildings: 187
  - Mount Airy homes: 298
  - FY 2009 energy sales: 343,871 MWh
  - Total Building Area Served: 31.7 million sq. ft.
  - Heat capacity: 289 MW
- Cooling Service
  - Signed downtown customers: 98
  - FY 2009 Energy Sales: 34,605,266 ton-hours
  - Building Area Served: 19.3 million sq. ft.
  - Chiller capacity: 32,937 tons

19

Combined Heat and Power

20

Locations of District Energy Systems
2,500 in the U.S.



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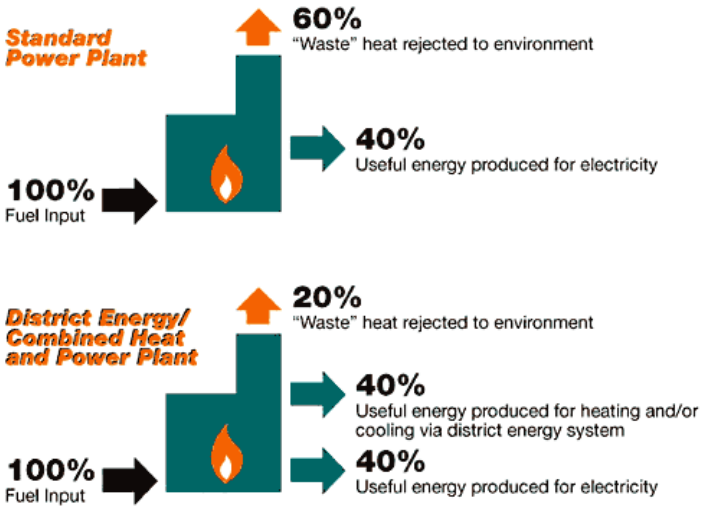
21

Energy-Efficiency Comparisons



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Waste-to-energy CHP Vestforbraending near Copenhagen, Denmark

- Location: Glostrup, west of Copenhagen, Denmark
- Largest WTE plant in Denmark
- Owner: 20 municipalities around Copenhagen
- Operator: I/S Vestforbrænding*
- Configuration: 1 X 17 MW, 1 X 20 MW
- Operation: 1998-2005
- Fuel: refuse; 500,000 tonnes per year
- Annual capacity: 700,000 tonnes of waste
- Boiler supplier: Volund
- T/G supplier: Allen
- Electricity to grid
- Heat for district energy interconnected with the regional district heating system in Copenhagen
- EPC: Elsam

*Denmark's largest public owned waste management company in Denmark.

23

Brownfields

"Brownfields are abandoned or underutilized property whose redevelopment is hindered by either real or perceived environmental contamination"

24

Brownfield Opportunities for WTE+CHP Advantages

- Reduces up front capital costs for developers by use of federal grants for clean-up and assessment
- Makes efficient use of local renewable energy sources and surplus heat
- Fuel flexibility improves energy security, local economy
- Energy dollars re-circulate in local economy
- Urban infrastructure – hidden community asset
- Connects thermal energy sources with users
- Many sites located inside Enterprise Zones, which are eligible for significant tax benefits
- Because these sites exist in the heart of urban areas, there is an accessible skilled labor pool easily available.
- Sites generally already have access to infrastructure: power, water, roads, rail, and bus routes

25

Selected Brownfields Programs

- US EPA grants for:
  - Assessments
  - Revolving Loan Fund (RLF)
  - Cleanup Grants
  - Job Training Grants
  - Targeted Brownfield Assessment (TBA) – ask the EPA region.
  - State/Tribal Response Programs
- US EPA Technical Assistance Sources –
  - New Jersey Institute of Technology (NJIT) serves communities in Regions 1, 2, and 3
  - Enterprise Corporation of the Delta, Inc (ECD) serves communities in Regions 4 and 6
  - Kansas State University serves communities in Regions 5 and 7
  - Center for Creative Land Recycling (CCLR) serves communities in Regions 8, 9, and 10

Source: ttp://www.safsf.org/documents/Brownfields%20Gardens%20Learning%20Network%20Call%20Presentation.pdf; and http://www.epa.gov/brownfields/overview/action_plan_2009.pdf

26

Selected Brownfields Programs (cont'd)

- US DOE
  - Grants and tax incentives for combined heating and cooling, and renewable energy
  - Facilitates transition of brownfields clean sites to beneficial reuses, including for renewable energy technologies
  - Feasibility studies for renewable energy projects
  - Technical outreach through:
    - Office of Energy Efficiency and Renewable Energy (EERE)
    - National Renewable Energy Laboratory (NREL)

Source: Brownfields Federal Programs Guide, USEPA, 2011 Edition.

27

Facts About District Energy and Greenhouse Gases

District Heating & Cooling - A vision towards 2020 - 2030 - 2050", DHC+ Technology Platform, 2009 says:

- District energy responsible for avoiding at least 113 million tons of CO2 emissions per year; corresponds to 2.6% of total European CO2 emissions.
- District cooling can reduce CO2 emissions by as much as 75% as compared to conventional electrical chillers
  Cities around the world can obtain major efficiency gains by coordinating their production of electricity and heating and cooling while reducing CO2 emission levels
- By implementing existing technologies it is possible to reduce CO2 emissions by as much as 40 per cent with district heating and district cooling systems

World Bank Comparative Study of different CO2 reducing investments revealed:

- *District Energy: Every DKK 1,000 (~ EUR 135) invested yields a CO2 reduction of 1 ton of CO2 per year*
- *Wind Power: DKK 1,000 invested leads to a reduction of 0.5 to 0.7 tons of CO2 per year*
- *Hydropower: DKK 1,000 invested gives a CO2 reduction of 0.6 - 1.3 tons CO2 per year.*
- *Only biomass exploited as fuel to avoid evaporation of methane from landfills do better than district heating - both gives 2.5 tons of CO2 reduction per year for every DKK 1,000 invested. However, it should be mentioned that both biomass and waste are fully applicable in a district energy system.*

Source: http://www.districtenergypartnership.com/da-DK/DISTRICT-ENERGY/REDUCING-CO2-EMISSION.aspx

28

Examples Selected Cities with Development Opportunities

- **Cleveland, OH**
  - St. Vincent Charity Hospital
  - Cleveland State University
  - KeyCorp Building
  - Metro Health Medical Center
  - Case Western Reserve University
  - Cleveland Browns Stadium
- **Denver, CO**
  - Denver Health and Hospital
  - Saint Joseph Hospital
  - University of Colorado Hospital
  - Colorado Convention Center
  - Auraria Higher Education Center
  - University of Denver
- **Portland, OR**
  - Portland State University
  - Portland Community College
  - Portland Marriott City Center
  - Oregon Health & Science University
  - Providence Portland Medical Center
  - Oregon Convention Center
- **Washington, DC**
  - Central Heating Plant, Washington, DC
  - Capitol Power Plant
  - George Washington University
  - University of the District of Columbia
  - Gallaudet University

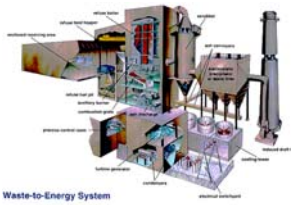
29

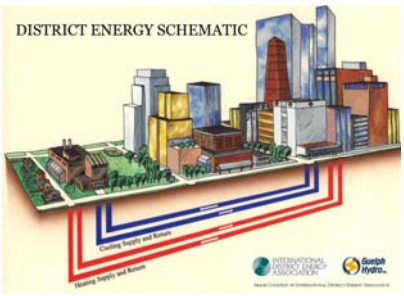
Project Building Blocks

- ❑ 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

30

Brownfield Site + WTE + CHP = Greater Energy Efficiency, Environmental Benefit, and Jobs!





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31

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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32