



Waste-to-Energy Lessons Learned: A 30-Year Evaluation on Why Projects Succeeded or Failed

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August 24, 2016



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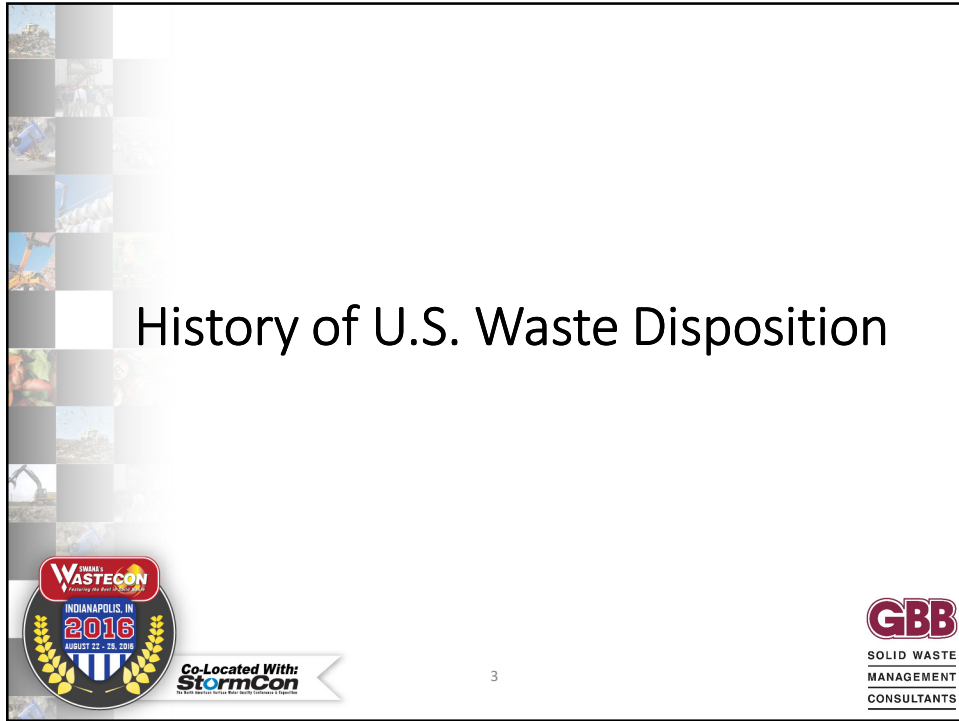
- 36 years and counting!
- Waste characterization and sourcing
- Economic, technical and environmental reviews
- Procurements
- Due diligence third-party reviews
- Process planning and conceptual designs
- Independent feasibility consultant




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History of U.S. Waste Disposition



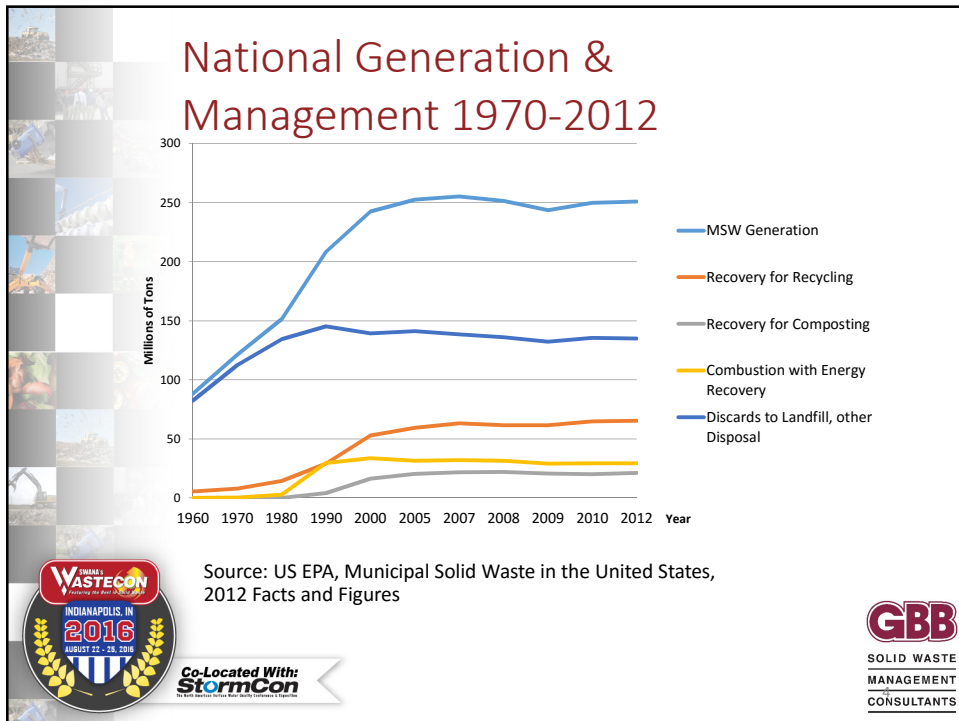
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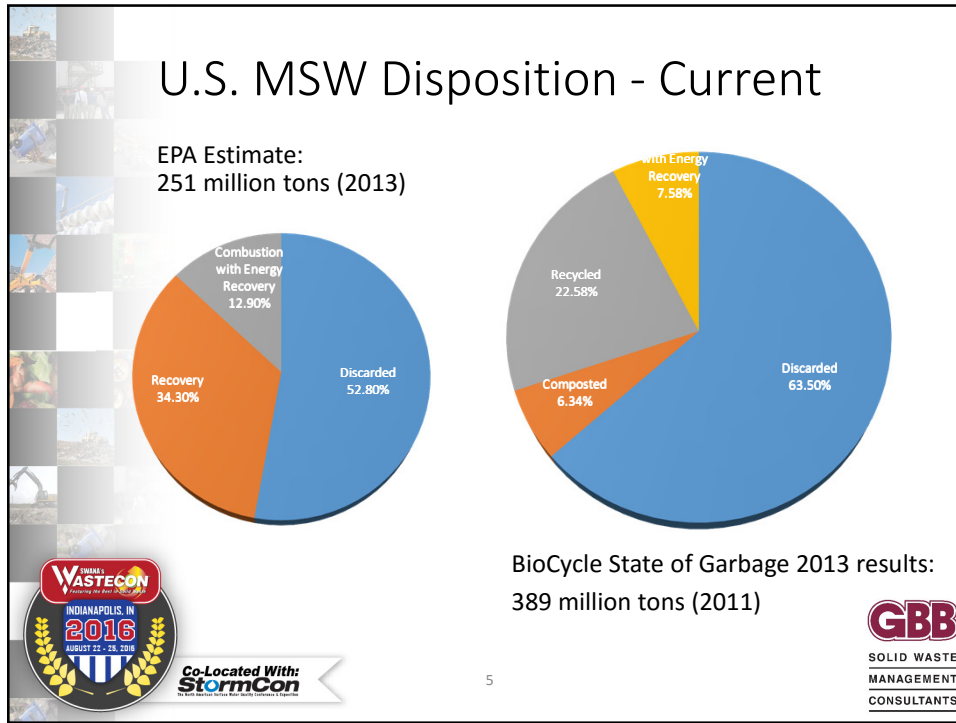
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U.S. Waste Management Infrastructure

Technology	US
Transfer Stations	3,350
Material Recovery Facilities (MRF)	586
Mixed Waste Processing Facilities & Hybrid MRFs	70*
Composting	2,300
Anaerobic Digestion	21
WTE	77
Landfills	1,908
Landfill Gas Projects (LFG)	636

*Excludes facilities that solely produce RDF

Meanwhile in the EU (1995-2014)

- Landfilling decreased 54%
- Recycling rate increased 166%
- Composting increased 170%
- Waste-to-Energy increased 100%

Source: EUROSTAT, 2016
http://ec.europa.eu/eurostat/statistics-explained/index.php/Municipal_waste_statistics

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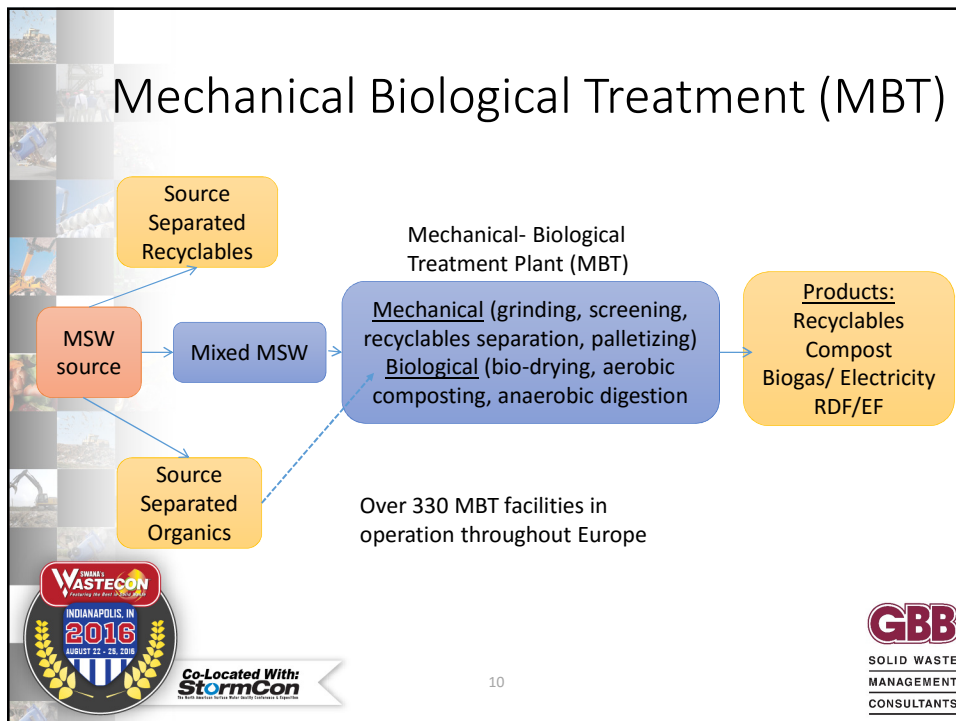
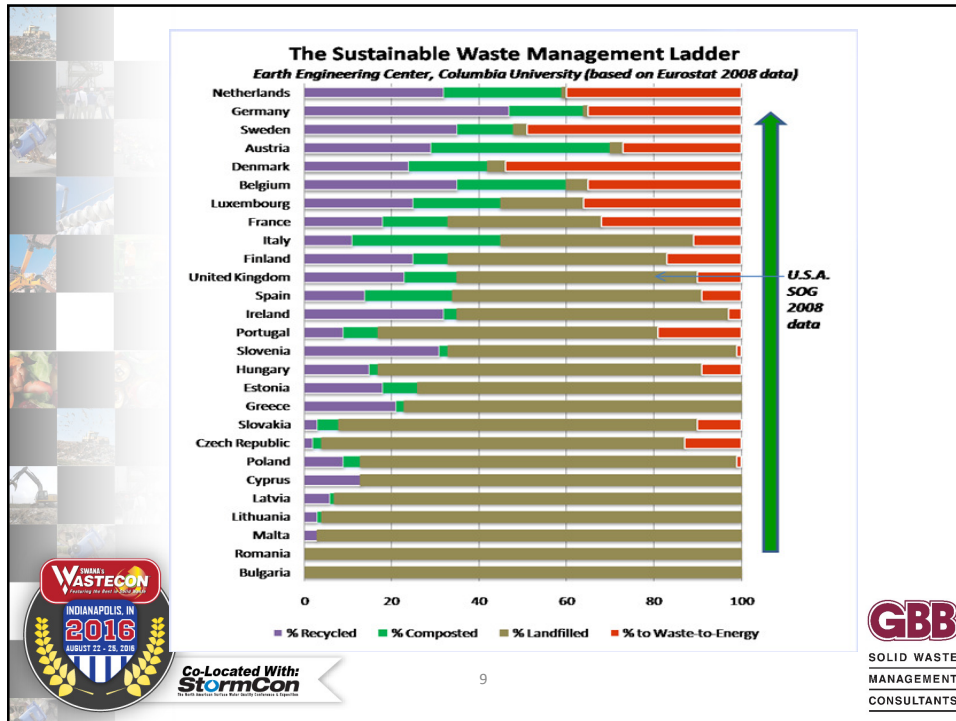
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Drivers in the EU

- Landfill Directive, 1999 - Limited the amount of biodegradable municipal waste going to landfills
- Feed in tariffs
- On average 80 €/t landfilling tax
- 18 EU Countries with landfilling material bans

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U.S. Opportunity: Create Circular Economy through Zero Waste to Landfill

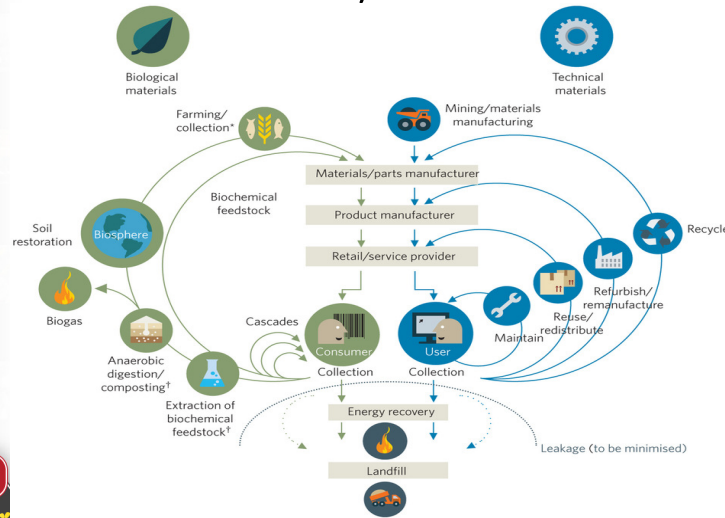


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Circular Economy



Source: Ellen MacArthur Foundation



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Industrial Eco-Parks – Co-locating Resource Recovery Operations

- Build environmental industry
 - Employment
 - Green jobs
 - Redevelopment
- Increase options for diversion
 - Keep resources at home
 - Connect generators with processors and remanufacturers
- Overcomes China’s “Green Fence”



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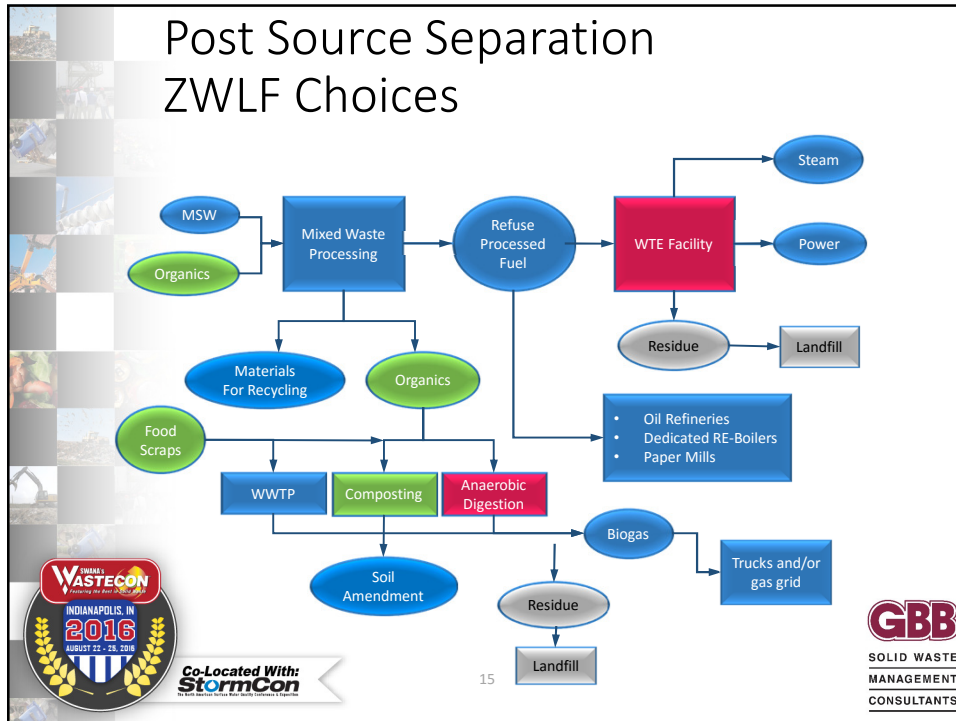
How do you overcome China’s Green Fence?

You build “Green Gates” to convert recyclables to manufacture into consumer products!



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Advanced Conversion Technologies

<p>476 Technology/Project Development Companies</p> <ul style="list-style-type: none"> • 28 Aerobic Composting • 106 Anaerobic Digestion • 30 Ethanol Fermentation • 117 Gasification • 30 Plasma Gasification • 31 Pyrolysis • 63 WTE: mass burn, modular, dedicated boilers, and RDF • 69 Others (e.g., thermal cracking, hydrolysis, steam reforming, agglomeration, de-polymerization) 	<p>157 Commercial or Demonstration CT Facilities</p> <ul style="list-style-type: none"> • 70 Anaerobic Digestion • 57 Gasification • 10 Plasma Gasification • 12 Pyrolysis
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Source: Gershman, Brickner & Bratton, Inc., June 2014



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Energy/Fuel Product Values - Key and Cyclical


	Product	Yield from 1 Ton MSW	Value Per Production Unit	Revenue Per Input Ton
Converting MSW to...	Power	500-650 kWh	@ \$0.05 / kWh	\$25-\$33
	Synthetic Crude	1 barrel	@ \$40 / barrel	\$40.00
	Ethanol	50 gallons	@ \$2.00 / gallon w/o subsidies	\$100.00
	Bio-diesel	35	@ \$3.57-\$4/gallon*	\$125-140

*Includes RINS and LCFS (California)



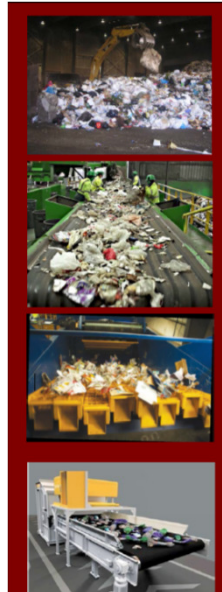
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The Evolution of Mixed Waste Processing Facilities 1970-Today




Prepared for:
The American Chemistry Council

Prepared by:
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Enerkem Waste-to-Biofuels – Edmonton Alberta, CA

- Refuse derived fuel gasification
- Produces ethanol and chemical intermediates
- Edmonton Waste Management Centre:
 - Refuse Derived Fuel production facility
 - Enerkem Waste-to-Biofuels Facility
 - Advanced Energy Research Facility




Source: SWANA Northern Lights 2013, Bud Latta, Processing and Disposal Waste Management Services, City of Edmonton



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**Example of
Industrial Eco-Park**



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RDF in Cement Kilns

- Huge consumer of fossil fuels
- Closed system: ash in fuels stays in cement
- 107 cement plants in 36 U.S. states
 - Top five companies collectively operate 49.6 percent of U.S. clinker capacity





Engineered Fuel (EF) Fluff Engineered Fuel (EF) extruded pellet

2016 - Entsorga breaks ground for a MBT facility
in Martinsburg, WV to produce fuel for Essroc




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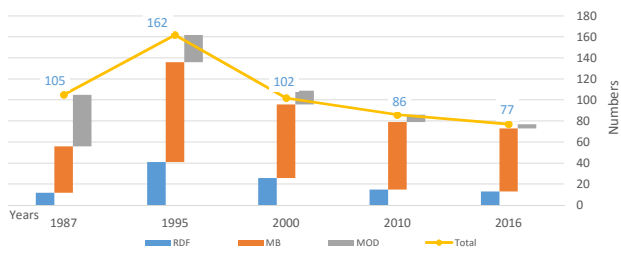
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WTE Project Cancellations and Closures



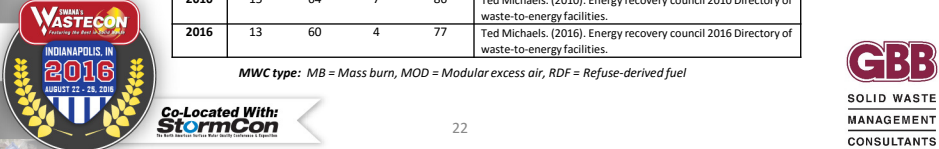
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WTE Plant Evolution in Past 30 Years



Year	Numbers of Plants			Total	Reference
	RDF	MB	MOD		
1987	12	44	49	105	EPA. (2006). An Inventory of Sources and Environmental Releases of Dioxin-Like Compounds in the United States for the Years 1987, 1995, and 2000.
1995	41	95	26	162	J.V.L. Kiser and J. Menapace. (1995). Integrated Waste Services Association, Washington, D.C.
2000	26	70	13	102	Jonathan V.L. Kiser & Maria Zannes. (2000). The IWSA Directory of Waste-To-Energy Plants.
2010	15	64	7	86	Ted Michaels. (2010). Energy recovery council 2010 Directory of waste-to-energy facilities.
2016	13	60	4	77	Ted Michaels. (2016). Energy recovery council 2016 Directory of waste-to-energy facilities.



MWC type: MB = Mass burn, MOD = Modular excess air, RDF = Refuse-derived fuel




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Reasons Project Developments Fail

- Technology risk
- Costs too high
- Inadequate waste supply
- Hurts recycling
- No sites
- Lack of political will
- Regulatory push back
- No financing



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WTE Projects Cancelled in 1980's

- City of San Diego, CA
- New York, NY (Brooklyn Navy Yard)
- City of Philadelphia, PA (Philadelphia Navy Yard)
- City of Seattle, WA
- Snohomish Co, WI
- Atlantic County, NJ
- Cape May County, NJ
- Middlesex County, NJ
- Passaic County, NJ


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1993 Research for Energy Recovery Council Predecessor by GBB

Monmouth County, NJ	Lost by 2 percent in county-wide referendum
City of San Francisco, CA	Referendum in neighboring Town of Brisbane killed project site.
St. Lawrence County, NY	Facility oversized; "put or pay" requirements; lack of political will.
Metro (Portland, OR)	Siting problems; delays; lost window for tax credits.
City of Seattle, WA	Citizen opposition and local siting concerns; need for landfill; put or pay would negatively effect recycling



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Reasons Procurements Fail

- *Costs too high*
- *No site*
- *Lack of political will*
- Technology risk
- *Hurts recycling*
- Inadequate waste supply
- Regulatory push back
- No financing



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WTE/CT Projects Stalled in 2000+

- USVI
- Allentown, PA
- St. Lucie County, FL
- New Hanover County, NC
- City of Baltimore, MD (Fairfield)
- Metro Vancouver, Canada
- Hawaii County, HI
- Glendale, AZ
- Cleveland, OH
- ECUA, FL
- City of Los Angeles, CA
- Marion County, FL
- Frederick County, MD
- Lake County, IN
- Clark County, NV
- Ada County, ID



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WTE Facility Closures

Harford, MD



Harrisonburg, VA



Portsmouth, VA



Nashville, TN



Wallingford, CT



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New WTE/MBT projects

Newest Traditional WTE: Solid Waste Authority of Palm Beach County, FL



- 3,000 TPD Mass Burn facility (1,040,000 TPY)
 - ✓ Babcock & Wilcox
 - ✓ 130 MW renewable power; enough for over 86,000 houses
 - ✓ \$668 million construction price
 - ✓ \$20.5 million first year O&M cost
 - ✓ Advanced emissions controls, ferrous and non-ferrous metals recovery
- Notice of Award – April 2011
- Groundbreaking – April 2012
- First Fire – February 2015
- Commercial operation – June 2015
- 12.7% plastics in MSW means over 132,000 TPY recovered as fuel



Source: SWA of Palm Beach County


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Air Emissions of Contenders for WTERT Award in 2006* and the comparison with New Palm Beach County WTE

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)	Maximum Concentration in Palm Beach WTE (mg/Nm ³)	Palm Beach WTE Test Results (mg/Nm ³)
Particulate matter (PM)	0.4	1.8	1	3.1	10	11	12	0.6 - 2.5
Sulphur Dioxide (SO ₂)	6.5	7.5	3	2.96	50	63	62.82	29 - 58
Nitrogen oxides (NO _x)	80	11	58	112	200	264	94	61 - 63
Hydrogen chloride (HCl)	3.5	0.5	0.7	8.5	10	29	30.67	2.3 - 4.1
Carbon Monoxide (CO)	15	7	15	24	50	45	114.5	19 – 27.5
Mercury (Hg)	0.002	0.005	0.002	0.01	0.05	0.06	0.025	0.0006
Total Organic carbon (TOC)	0.5	NA	0.9	1.02	10	n/a	n/a	n/a
Dioxins (TEQ)	0.002	0.002	0.015	0.02	0.10	0.14	0.001	0.0002-0.0004

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



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New WTE/MBT projects



Hartford, CT (RDF dedicated boiler)

- Hartford, CT (MIRA)
 - In procurement
- Housatonic Resource Recovery Authority, CT
 - In procurement
- Berkeley County, WV
 - Ansorga
- City of Hood River/The Dalles, OR
 - In procurement
- Hampton, ME
 - Fiberight
- Lake County, OR
 - Red Rock Biofuels
- Metro Portland, OR
 - In procurement
- Lebanon, TN
 - PHG
- Prince William County, VA
 - In procurement



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Municipal AD Projects Under Development

City of Portland, OR
- Columbia Biogas

County of Santa Barbara,
CA – Mustang Renewable

City of Perris, CA – CR&R



Town of Brunswick, ME
Johnson, Rhode Island- Blue
Sphere

Prince Georges County, MD – TBD

**Prince William County, VA – Freestate
Farm**

City of Charlotte, NC - Blue Sphere

City of Columbia, SC - W2E




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Project Building Blocks


Regulatory impetus and incentives	Limited or high disposal costs	Waste Supply	Markets
Site with good logistics that can be permitted	Landfill for residues	Contractor with resources and proven technology	Capital
Ability to pay service fees	Finance	Compatibility with High Level of Recycling	Political Will



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Pre-Develop Project Building Blocks

- Include a site
- Address recycling as part of future solution
 - In certain states, organics too
- Show understanding of cost implications and how it will be funded
- Offer waste supply strategy and commitment
- Include service agreement showing risk posture
- Involve internal decision-makers and stakeholders
- Have internal team with resources and advisors

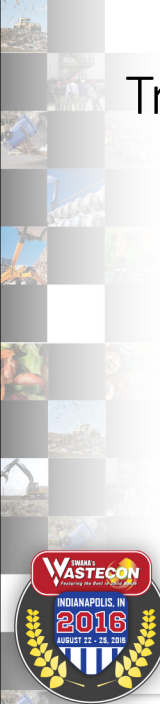


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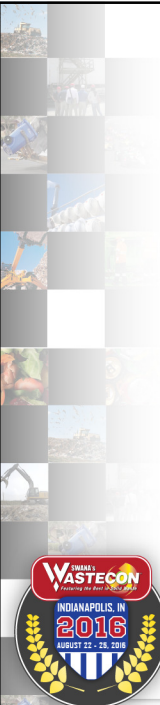

Trends

- Significant focus on AD projects, especially in California
 - Wastewater treatment plants with excess AD capacity interested in adding food waste
- Several conversion technologies to watch carefully, including “One-Bin”
- Mixed waste processing key to Zero Waste To Landfill
- Increased public sector involvement needed and willing to pay more for increasing diversion
- ‘Zero Waste’ proponents fight non-recycling only alternatives



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Questions, Answers, and Thank you!!

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