



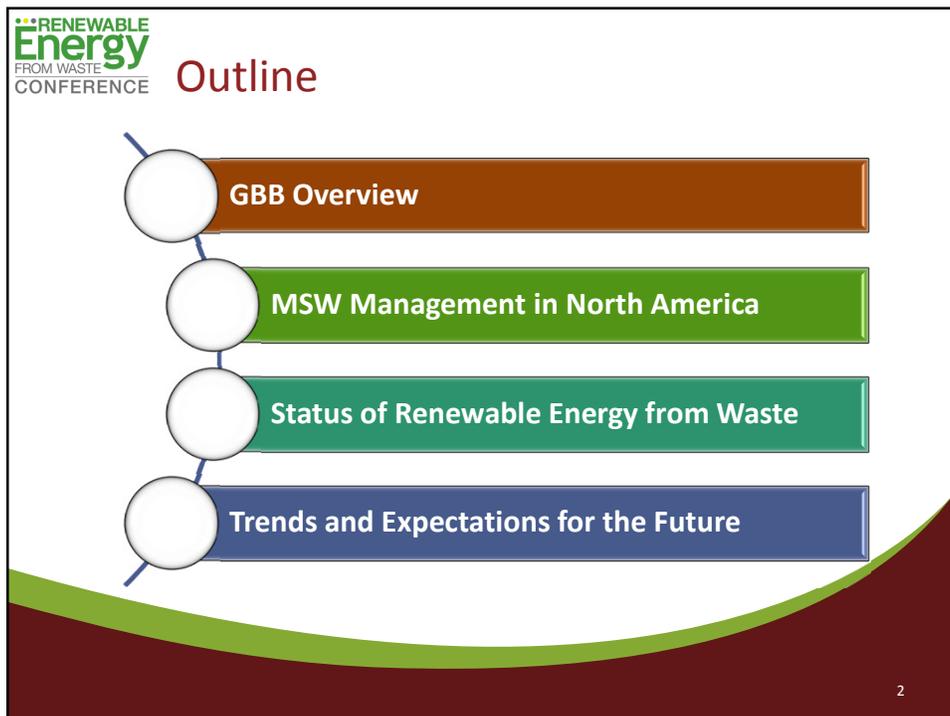
RENEWABLE Energy
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Update on Waste Conversion Progress in North America

San Jose, CA

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

November 18, 2014



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Outline

- GBB Overview
- MSW Management in North America
- Status of Renewable Energy from Waste
- Trends and Expectations for the Future

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GBB OVERVIEW

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GBB -- Quality – Value – Ethics – Results



- Established in 1980
- Solid Waste Management and Technology Consultants
- Helping Clients Turn Problems into Opportunities

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GBB Waste Technology Services

- Economic, technical, and environmental reviews
- Markets development
- Process planning and design
- Waste characterization and sourcing
- Procurement and negotiation assistance
- Independent feasibility consultant
- Technology due diligence
- Acceptance testing and operations monitoring

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Renewable Energy from Waste

NOVEMBER 17-20, 2014 SAN JOSE, CALIFORNIA

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Food Waste or Fuel Source?

DEPARTMENTS - CRITICAL THINKING

Harvey Gershman
OCTOBER 16, 2013

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www.rewmag.com

Halvee... take out the garbage... it stinks! my mom used to remind me of my household chore growing up in Pawtucket, R.I., in the '60s. We had a 30-gallon can for food waste in the back corner of our lot waiting to be collected by the city and delivered to pig farmers for feed. Neighboring Providence did it a little differently. It had to be bundled in newspapers and set out for collection, eventually to find its way to pig farmers.

HARVEY W. GERSHMAN

Fast-forward to the new millennium. We are serious about increasing recycling even more by going after organics. The U.S. Environmental Protection Agency reports that food waste accounts for approximately 21 percent of landfilled municipal solid waste (MSW), or around 35 million tons per year (TPY). This waste is a resource that can be used to produce bio gas, for power production or

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WASTE MANAGEMENT IN NORTH AMERICA

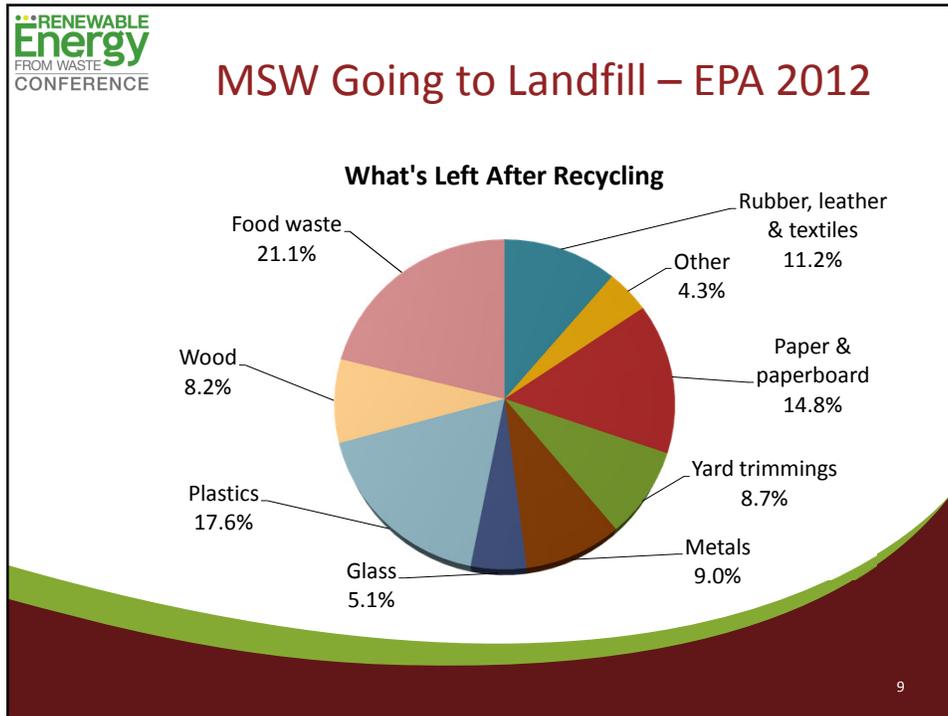
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MSW Disposition in the U.S.

Source	Total Tons	Year	Discarded	Recycled	Composted	Combustion with Energy Recovery
EPA Estimate	251 million tons	2012	54%	26%	8%	12%
SOG 2013 results	389 million tons	2011	63.50%	22.58%	6.34%	7.58%

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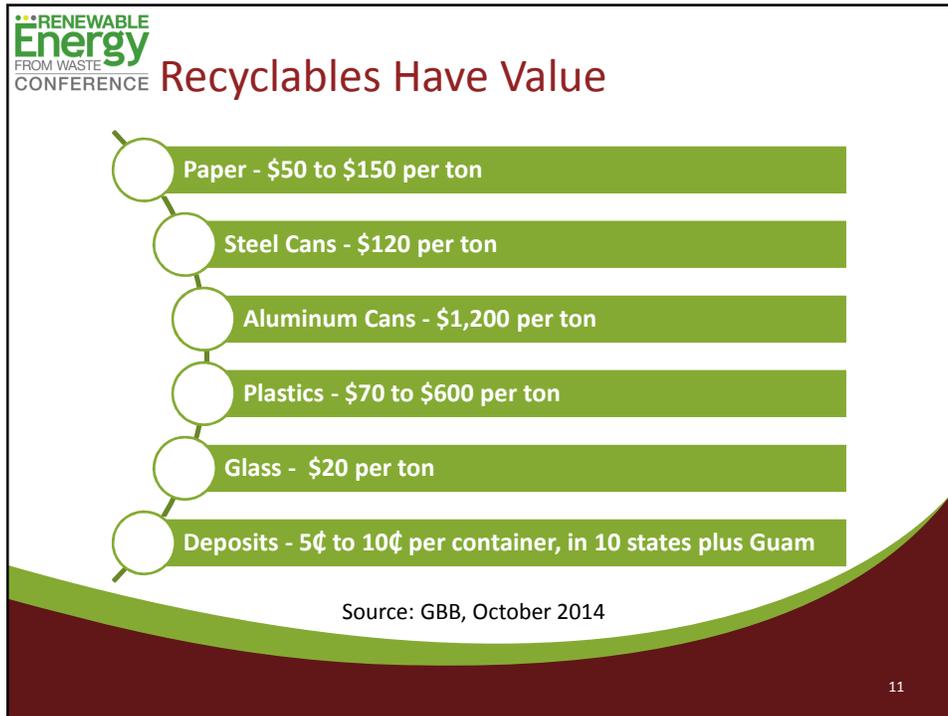
U.S. Waste Management Infrastructure

Facility	Number
Material Recovery Facilities (MRF)	586
Composting	2,300
Mixed Waste Processing Facilities & Hybrid MRFs	70*
Mass Burn WTE	65
Modular WTE	9
RDF -Processing or Combustion	20
Anaerobic Digestion	19
Transfer Stations	3,350
Landfills	1,908
Landfill Gas Projects (LFG)	636

*Excludes facilities that solely produce RDF

Source: GBB, October 2014

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Energy/Fuel Product Values Are Key

Converting MSW to...	Product	1 ton MSW yields	Value Per Production Unit	Revenue Per Ton
	Power	600 kWh	@ \$0.06 / kWh	\$36.00
	Synthetic Crude	1 barrels	@ \$80 / barrel	\$80.00
	Ethanol	50 gallons	@ \$2.50 / gallon	\$125.00

++ sale of chemical feedstocks, heat and/or recovered metals
System Capital Costs and O&M Costs impact the NET MSW costs!

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Legislative Highlights

California – MSW allowed as engineered fuel to power cement kilns; new goal of 75 % diversion

Vermont – Universal Recycling Act requires diversion of food waste, yard waste, and wood debris from landfill, continued EPR and e-waste laws

Massachusetts – ban on disposal of food and yard waste, policies to encourage growth of AD

Rhode Island - beginning Jan. 1, 2016, required separation of organic waste including food scraps and composting or other beneficial reuse

Connecticut - Ban of commercial food waste from landfills for generators of two or more tons of food waste

U.S. Renewable Fuel Standards and Biofuels Pathways

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STATUS OF RENEWABLE ENERGY FROM WASTE PROJECTS

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Increased Interest Worldwide in Renewable EfW 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 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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Some Projects Under Development...

WTE as Renewable
■ Yes
■ No

● Advancing new conversion facilities with contractors
● In procurement for conversion contractor
● Advancing AD facilities

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Mass- Burn WTE Facilities Under Construction



- Solid Waste Authority of Palm Beach County, FL;**
 - 3,000 TPD
 - 130 MW
 - \$668 million construction price
 - \$20.5 million first year O&M cost
 - Groundbreaking - April 2012
 - Expected commercial operation 2015
- Durham/ York Energy Center, Canada**
 - 385 TPD
 - 17.5 MW
 - \$284 million construction price
 - Start construction 2011
 - Expected commercial operation end of 2014

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Mixed Waste Processing for Significant Landfill Diversion

- More recyclables and organics
 - Recyclables can be an additional 15 to 35%
 - Organics can be an additional 20%
- Use cleaner/drier Refuse Derived Fuel in:
 - Existing mass burn facilities
 - Cement kilns, biomass, and coal boilers
 - New dedicated boilers/WTE facilities permitted with MACT
 - Conversion technologies

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Montgomery, AL - Infinitus

- High-tech 80,000 square feet “state-of-the-art” Mixed Waste Processing Facility
- Capital cost in excess of \$30 million
- First “One Bin for All” in 21st Century in the U.S.
- Main equipment subcontractor, Bulk Handling Systems
 - One-line, 40 ton per hour input for 100,000 tons per year
 - 60 % material recovery guarantee plus other organics separation capabilities
- Commercial operations began April 2014



Source: GBB 2014

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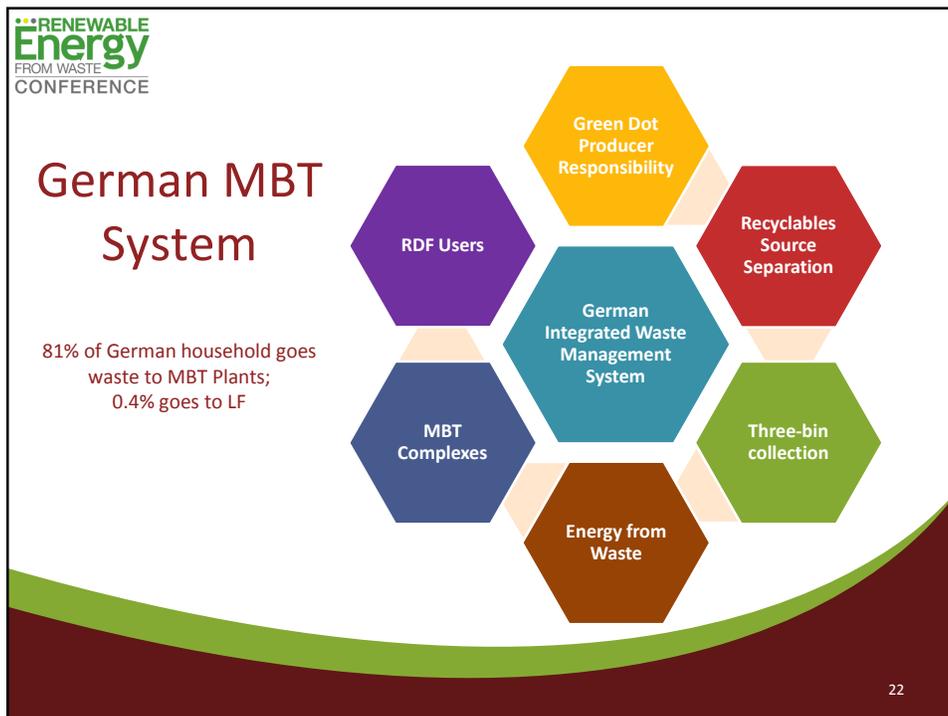
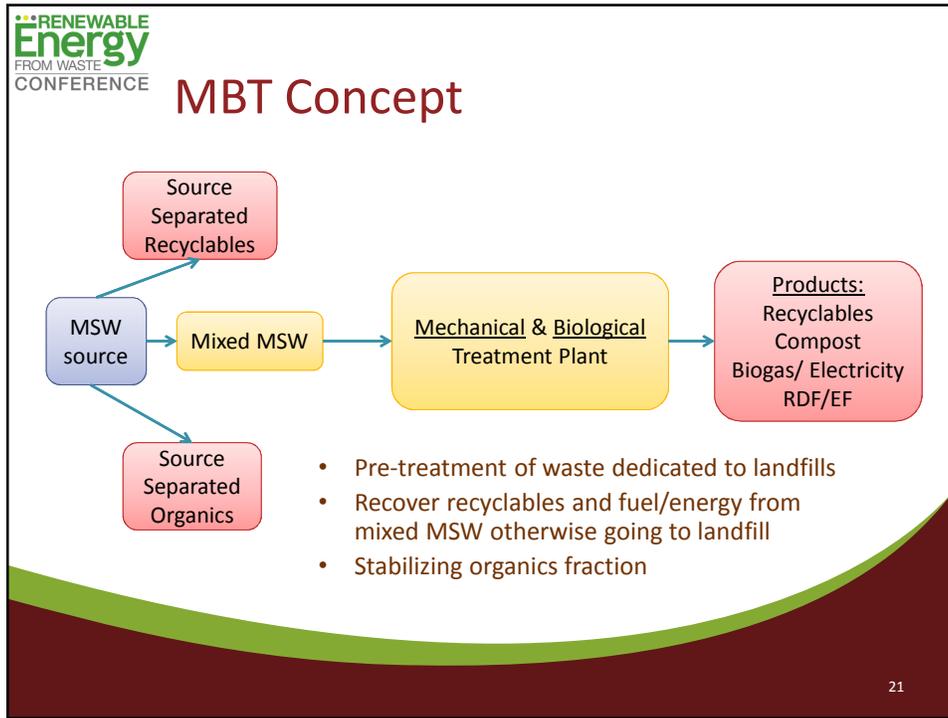
RDF in Cement Kilns



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

- Huge consumer of fossil fuels
- Closed systems; 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
 - Estimated 76.7 percent of U.S. clinker capacity is owned by companies HQ'd outside of the U.S.
- 16 plants in Canada
 - Eight companies operate in five provinces and produce over 98% of the cement used in Canada
 - Nearly 90% of capacity under multinational ownership

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Biomass to Liquid Fuel Technologies

Company	Technology	Product	Status	Featured plants in N. America	No. of commercial plants
 Enerkem	Gasification	Methanol/ Ethanol	Commercial	Pilot: Sherbrooke, CAN Demo: Westbury, CAN Commercial: Edmonton, CAN Varenes, CAN and Pontotoc, MS	1
 INEOS Bio	Gasification	Ethanol/ Electricity	Commercial	Vero Beach, FL – 8 MM gal/yr and 6 MW power	1
 Fulcrum BioEnergy	Gasification	Ethanol	Demo	Reno, NV, sierra biofuels	none
 Fiberight	Enzymatic Fermentation	Ethanol	Demo	Demo: Lawrenceville, VA Commercial: Blirstown, IA – 6 MM gal/yr – under development	none

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Gasification Technologies

Company	Product	Status	Featured plants	No. of commercial plants
 ALTERNRG	Syngas	Commercial	Commercial: Tees Valley, UK 1,050 TPD	1
 COVANTA CLEERGAS™	Syngas & Electricity	Commercial	Commercial: Tulsa, OK 350 TPD	1
 PlascoEnergy GROUP	Electricity	Commercial (under development)	Demo: Ottawa, CAN Commercial: Ottawa, CAN	none

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Plastic to Oil Technologies

- Thermal conversion in the absence of oxygen
- Non-recyclable plastics to oils, fuels
- Plastics-to-Oil Technologies Alliance formed by ACC

Source: RES Polyflow



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Anaerobic Digestion

Biological degradation of organic material in absence of oxygen

- Biogas fuel for electricity and/or heat production; can be conditioned to pipeline quality
- Digestate for soil amendment, animal bedding, or rolled into a composting process
- 19 plants operating in the US



Quasar Energy- Cleveland, Ohio



CR&R Eisenmann – Perris, CA
(under construction)

Source: GBB 2014

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Companies in U.S. at Work with AD

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Anaerobic Digestion Commercial Projects

Company	Product	Feedstock	Featured plants in N. America	No. of commercial plants
HARVEST Power of We™	Electricity/CNG	Mixed org. waste/ food waste/ yard waste	Richmond Energy Garden, Canada London Ontario Energy Garden, Canada Energy Garden in Bay Lake, FL	3
quasar energy group	Electricity/CNG	FOG/ food waste/ biosolids/ biomass	Wooster Water Pollution Control Plant, OH Collinwood BioEnergy, Cleveland, OH Haviland Energy, OH	13
ZeroWaste™ ENERGY, L.L.C. Recovery and Energy with Zero Waste	Electricity/CNG	Food waste/ yard waste	Monterey Regional Waste Management District ZWEDC – San Jose, California SSF Scavenger – South San Francisco, California	4
CR&R	CNG	Food waste/ yard waste	Perris, CA	1 under construction
eci Bio Energy	Electricity	Source Separated Organics	Disco Road and Dufferin, Toronto Canada	2

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State of the U.S. LFG Industry

- LFG is extracted from landfills using a series of wells and a blower/flare system
- Collected gas goes to a central point for treatment and conversion/sale
- 636 operational LFG energy projects in the U.S. [July 2014]
 - 1,978 MW and 305 mmscfd
- EPA estimates an additional 440 MSW landfills could turn their gas into energy
 - Enough to power 500,000 homes



Maui, HI LFG System

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Technologies and Risk

Alternative	Risks/Liability	Risk Summary
Processing for Recyclables and Fuel	Proven commercial technology	Low
Composting	Proven commercial technology	Low
Mass Burn Combustion	Proven commercial technology	Low
RDF Combustion	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; limited large-scale plants in operation; product quality issues	Moderate to High
Pyrolysis and Gasification	Previous failures at scale; no operating experience with large -scale operations in the U.S.; full-scale demonstrations nearing operation	High
Landfill Gas Recovery	Proven commercial technology	Low

Source: Gershman, Brickner & Bratton, Inc. 2014

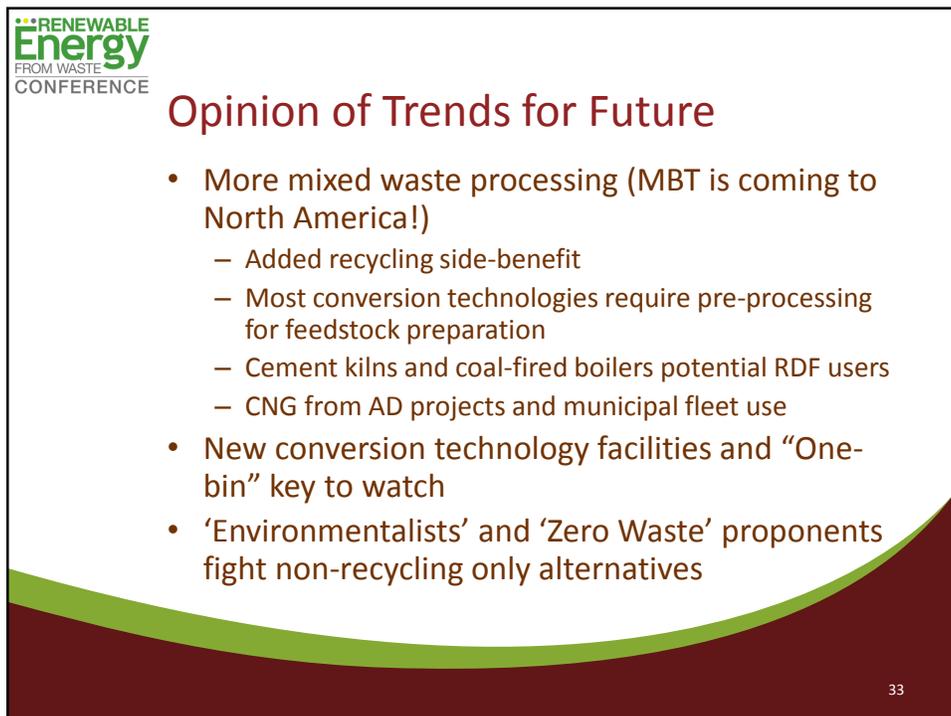
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TRENDS, EXPECTATIONS, AND OPPORTUNITIES FOR THE FUTURE

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Opinion of Trends for Future

- More mixed waste processing (MBT is coming to North America!)
 - Added recycling side-benefit
 - Most conversion technologies require pre-processing for feedstock preparation
 - Cement kilns and coal-fired boilers potential RDF users
 - CNG from AD projects and municipal fleet use
- New conversion technology facilities and “One-bin” key to watch
- ‘Environmentalists’ and ‘Zero Waste’ proponents fight non-recycling only alternatives

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Legislation and Regulations

- *Will more states ban food scraps from disposal?*
- *Will North American landfill disposal become more expensive?*
- Permitting needs to be streamlined/rational
- Several states stepping up recycling/diversion goals and producer responsibilities
- USEPA needs to help lead the way with RFS2 and EF rules
- *Will there be local leadership willing to make changes to their waste management systems at generally higher costs?*
- ***Waste is very recyclable and it is also very renewable!***
- ***A lot less waste to landfills is better!***

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Questions and comments?

Thank you!

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