Conversion Technologies and Trends

Presented by

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

September 11, 2015

SOLID WASTE MANAGEMENT CONSULTANTS

GBB Quality – Value – Ethics – Results

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

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Harvey Gershman

"Earth Day 1970 first inspired my career to focus on helping do better things with waste. And, I have been able to do just that for the past 40+ years."

Harvey Gershman
President and Co-Founder

Specialties: Strategic thinking and planning; procurement and negotiation assistance; system administration; change management; and project financing coordination.

- Orchestrates plans for implementation of sustainable, efficient integrated waste management practices and technologies accepted by the community and leadership
- Thought leader on alternative and developing technologies
- Expertise in every aspect of solid waste management systems
  - Collection
  - Recycling
  - Waste to Energy
  - Transfer Stations and Landfills
  - Market and Feasibility Studies
  - System and Business Planning
  - Procurement and Contracting
  - Project Financing

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Outline

- U.S.MSW Disposal Infrastructure
- Conversion Technologies
- Mixed Waste Processing
- Conclusions and Trends

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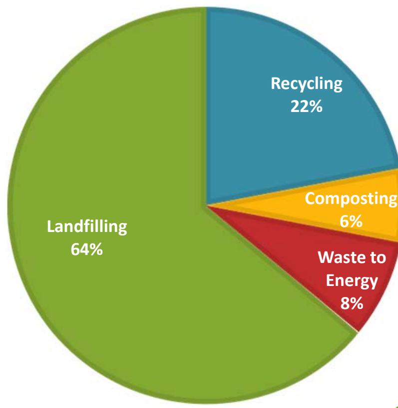
MSW Disposal and Recycling

Disposal Facility	Total MSW (million tons)
Recycling	55-77
Composting	15-21
Waste to Energy	20-28
Landfilling	160-224
TOTAL	250-350 Million Tons



Source: EPA 2012 estimate
and Biocycle 2012 estimate

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U.S. Waste Management Infrastructure

Technology	Number
Curbside Recycling Programs	9,000+
Source Separation Programs	-No Data-
Material Recovery Facilities (MRF)	586
Mixed Waste Processing Facilities (MWPF)	51
Composting	2,300
Anaerobic Digestion	19
Transfer Stations	3,350
WTE	84
Landfills	1,908

Source: GBB 2015

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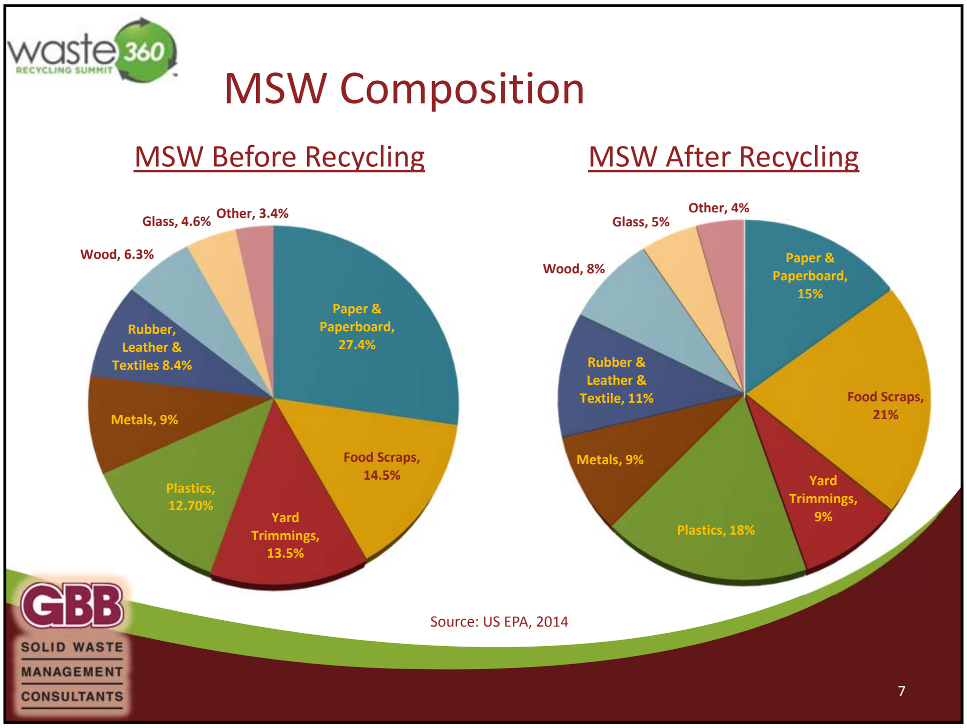
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MSW Composition
MSW Before Recycling
Paper & Paperboard, 27.4%
Food Scraps, 14.5%
Yard Trimmings, 13.5%
Plastics, 12.70%
Metals, 9%
Rubber, Leather & Textiles 8.4%
Wood, 6.3%
Glass, 4.6%
Other, 3.4%
MSW After Recycling
Paper & Paperboard, 15%
Food Scraps, 21%
Yard Trimmings, 9%
Plastics, 18%
Metals, 9%
Rubber & Leather & Textile, 11%
Wood, 8%
Glass, 5%
Other, 4%
Source: US EPA, 2014
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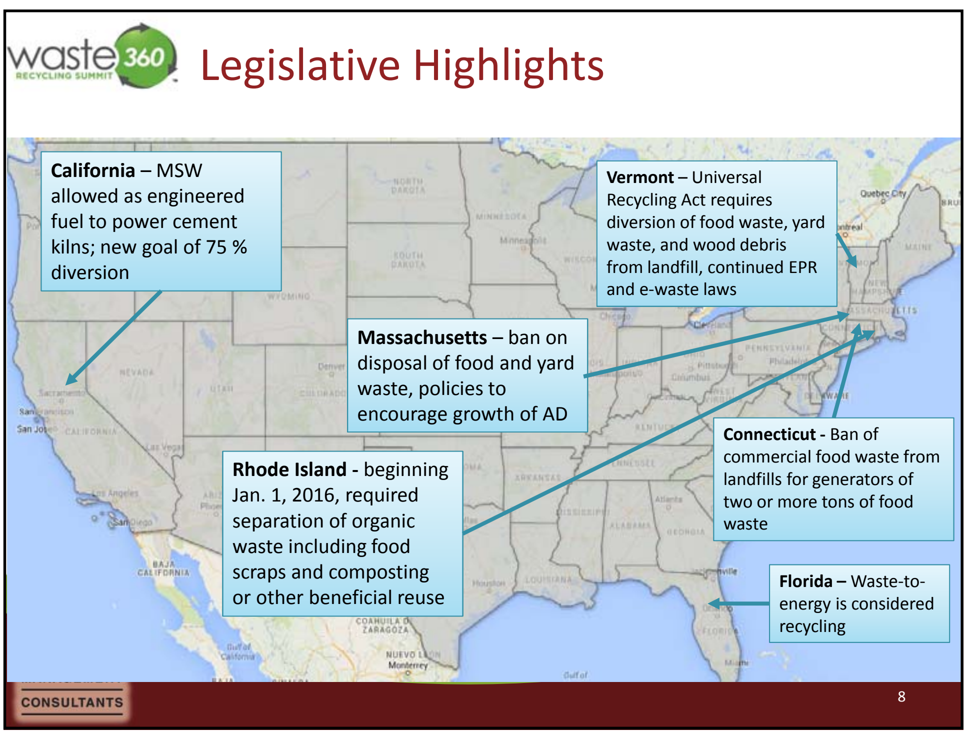
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Legislative Highlights
California – MSW allowed as engineered fuel to power cement kilns; new goal of 75 % diversion
Vermont – Universal Recycling Act requires diversion of food waste, yard waste, and wood debris from landfill, continued EPR and e-waste laws
Massachusetts – ban on disposal of food and yard waste, policies to encourage growth of AD
Connecticut - Ban of commercial food waste from landfills for generators of two or more tons of food waste
Rhode Island - beginning Jan. 1, 2016, required separation of organic waste including food scraps and composting or other beneficial reuse
Florida – Waste-to-energy is considered recycling
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Increased Interest in Renewable Energy from Waste Technologies

>579 Technology and/or Project Development Companies Worldwide

150 Commercial or Demonstration Facilities with MSW Worldwide

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

Source: GBB, 2014

Contributing factors:

- Renewable energy policy
- Greater revenue potential
- Funding (grants/loans)
- Local governments desire to be greener
- GHG considerations
- Landfill waste diversion goals
- Local jobs
- Increasing collection/disposal fees

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Technologies and Risk

Source: Gershman, Brickner & Bratton, Inc. 2014

Technology	Risks/Liability	Risk Summary
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
Composting	Proven commercial technology	Low
Food & Yard 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
Automated Material Processing	Proven commercial technology	Low

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WTE (mass burn) plants in the US

Status of WTE facilities	
Operating Facilities	80
Inactive Facilities	4
Total number of facilities	84
Facilities under construction	1

Alexandria, VA – Covanta (mass burn facility)

Hartford, CT (RDF dedicated boiler)

WTE facilities by Technology	
Mass Burn	64
Refuse Derived Fuel (RDF)	13
Modular	7

Source: Energy Recovery Council, 2014

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Project Status - Solid Waste Authority of Palm Beach County, FL

Source: SWA of Palm Beach County

- Able to divert 1.04 million tons of waste from landfill per year (3,000 TPD)
- Supplies 86,000 homes with “renewable” energy
  - In FL, 1 WTE MW counts as 1 Ton recycling
- Built, Owned, Operated by Babcock & Wilcox
- Construction price: $668 million
- O&M cost: $20.5 million annually
- Advanced emissions controls, ferrous and non-ferrous metals recovery
- Commercial ops – June 2015

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Anaerobic Digestion/Composting

- Biological decomposition of the organic material in absence of oxygen
- >20 commercial plants that take source separated organics
- Feedstock: Commercial food waste, residential SSO, co-digestion at WWTP and farms
- Two main type: high solids AD and low solids AD

Anaergia
OWS Organic Waste Systems
EISENMANN
HARVEST Power of We
quasar energy group
Hitachi Zosen INOVA
ZeroWaste ENERGY, LLC. Recovery and Energy with Zero Waste
KOMPOGAS

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Gasification

- Partial combustion in an air-controlled environment
- Product: Syngas for production of electricity, chemicals/ fuels (ethanol)
- Feedstocks
  - Engineered fuel from MSW
  - Biomass
  - Agricultural waste

ALTERNRG
COVANTA CLEERGAS™
IWT Interstate Waste Technologies
Enerkem
Fulcrum BIOENERGY
SIERRA ENERGY
INEOS Bio

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Enerkem Waste-to-Biofuels – Edmonton Alberta, CA

- Refuse derived fuel for 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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INEOS Bio Gasification - Vero Beach, FL

- Gasification and fermentation facility
- Processes yard, wood and vegetative waste
- MSW to Bioethanol yet to be proven
- Vero Beach, Indian River County, FL- commercial demonstration facility
- Produces 8 million gal/year ethanol and 6 MW (gross) of electric power

INEOS Bio

Indian River BioEnergy Center

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Fulcrum Bioenergy – Reno, NV

- Gasification followed by fuel synthesis
- First commercial plant under construction
- Producing 10 million gallons of jet fuel per year for Cathay Pacific Airways
- EPC Contractor- Abengoa
- Commercial operation expected 3rd quarter of 2017

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AlterNRG – Tees Valley, UK

- 1,000 tons-per-day Plasma gasification facility
  - Front end MWPF
  - AlterNRG/Westinghouse plasma reactor technology
- Co-located processing for Tees Valley 1, and Tees Valley 2

Source: AlterNrg

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Emerging MWP/CT Projects and Procurements

- City of Houston, TX – MWP/CT
- County of Santa Barbara, CA – MWP/CT
- Edmonton, Alberta, Canada – AD
- Emerald Coast Utilities Authority (Pensacola), FL - MWP
- King County, WA – AD
- Prince George's County, MD – MWP/AD/CT
- US Virgin Islands – WTE

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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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Energy/Fuel Product Values - Key and Cyclical

Converting MSW to...

Product	Yield from 1 Ton MSW	Value Per Production Unit	Revenue Per Input Ton
Power	500-650 kWh	@ $0.06 / kWh	$30-$39
Synthetic Crude	1 barrel	@ $40 / barrel	$40.00
Ethanol	60 gallons	@ $2.00 / gallon w/o subsidies	$120.00

++ sale of chemical feedstocks, heat and/or recovered metals

but, System Capital Costs and O&M Costs impact the NET MSW costs

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Brad K

Let's Make Bio-Diesel!

	US	US + CA
Btu Value of Diesel /Gal (HHV)	138,490	138,490
Gallons/Ton of MSW	35	35
Diesel MMBtu/Ton MSW	4.847	4.847
RIN+LCFS Value $/MMBtu	$11.70	$14.04
Value per Ton	$56.71	$68.05
Diesel Revenue @ $2 per Gallon	$70.00	$70.00
Total, Value Diesel Value per Ton	**$126.71**	**$138.05**

RIN - Renewable Identification Numbers

LCSF - Low Carbon Fuel Standard (California)

Processing Technology Vendors

AMUT GROUP

Infinitus ENERGY

RRT

BHS What's next.

LINDNER America LLC

STADLER America

CP

MACHINEX

VAN DYK recycling solutions

Mustang Renewable Power Ventures, LLC

Vecoplan

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Mixed Waste Processing Report


The Evolution of Mixed Waste Processing Facilities
1970-Today

Prepared for:
The American Chemistry Council

Prepared by:
Gershman, Brickner & Bratton, Inc.

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http://plastics.americanchemistry.com/Education-Resources/Publications/The-Evolution-of-Mixed-Waste-Processing-Facilities.pdf

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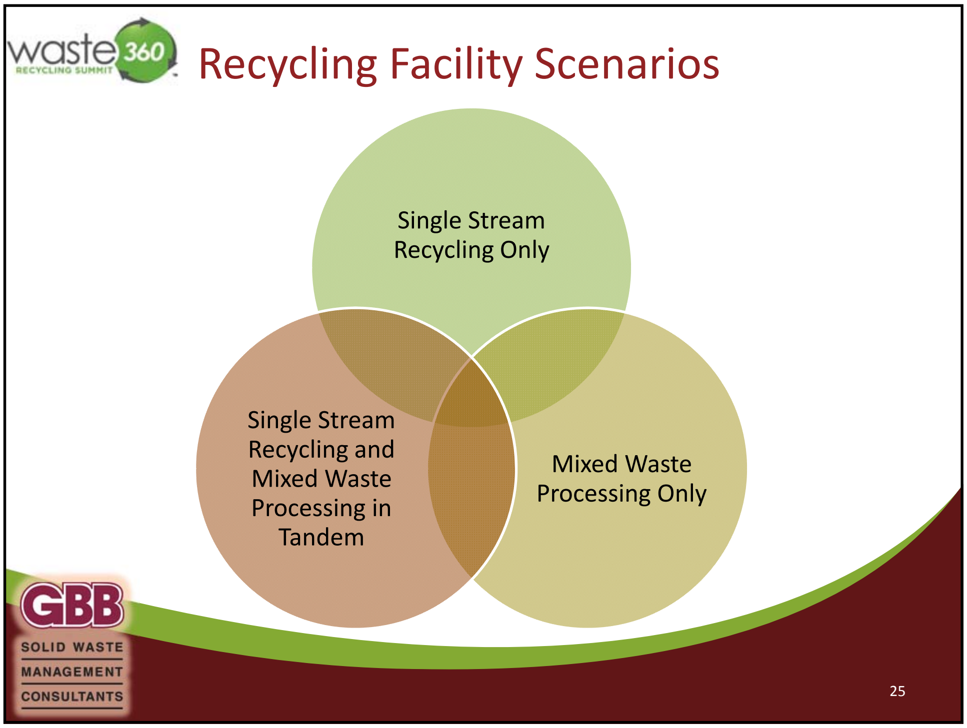
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Recycling Facility Scenarios
Single Stream Recycling Only
Single Stream Recycling and Mixed Waste Processing in Tandem
Mixed Waste Processing Only
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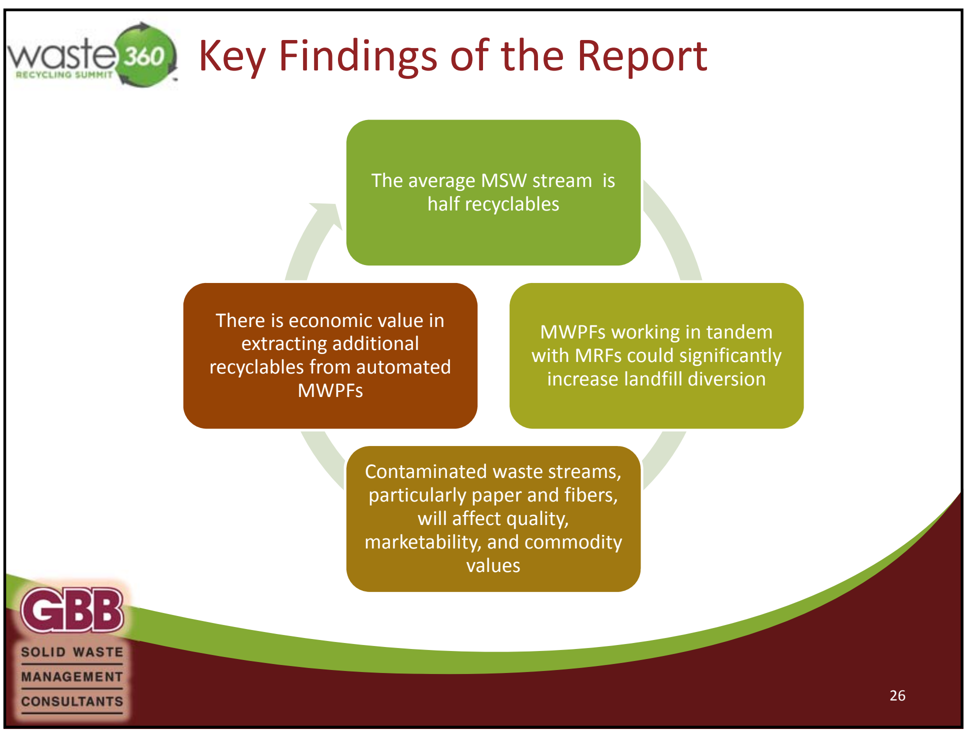
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Key Findings of the Report
The average MSW stream is half recyclables
There is economic value in extracting additional recyclables from automated MWPFs
MWPFs working in tandem with MRFs could significantly increase landfill diversion
Contaminated waste streams, particularly paper and fibers, will affect quality, marketability, and commodity values
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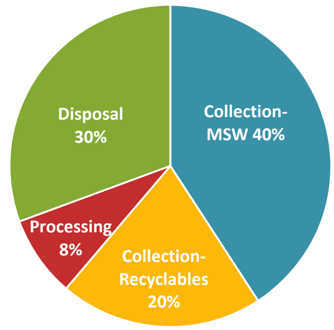
Cost of Collection and Disposal

- Collection
  - Residential solid waste : $10 - $40 USD$ per month per household
  - Residential recycling $2 - $4 per month per household
- Commercial waste
  - Charged on a per month per box basis, and may include a separate pass-through cost for disposal charges.
  - 2 cubic yard box serviced once per week = $60 - $140 per month
  - 6 cubic yard box serviced once per week = $130 - $280 per month
- WTE tipping fee $68/ton
- Landfill tipping fee $48/ton
- Costs and revenues affected by:

Community size	Government structure	Politics
Facilities used	Waste supply agreements	Revenue sharing back to customer



Cost of collection and disposal broken down by service

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Why develop and host a park?

- Build environmental industry
  - Employment
  - Green jobs
  - Redevelopment
- Increase options for diversion
  - Keep resources at home
  - Create a solution to the Green Fence in China

Supports windmills—not actually operating a windmill

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Conclusions and Trends

- 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; combine with landfill gas; use for collection fleets
- New conversion technology and “One-bin” key to watch
- Costs: probably higher; collection savings potential to offset
- ‘Environmentalists’ and ‘Zero Waste’ proponents fight non-recycling only alternatives

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www.rewconference.com

- Premier Event in the Waste Conversion Industry
- Educational Sessions (2-days)
  - 40+ industry experts covering complex subjects & providing real-world advice
- Workshop (Half-day)
  - Planning for Success - Public Sector Planning and Implementation of Waste Conversion Projects
- Tour
  - Harvest Power's Energy Garden in Orlando

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Thank you!!
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