Anaerobic Digestion (AD) to Manage Food Waste – Worth Considering?

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GBB Overview

- Established in 1980
- Solid Waste and Technology Consultants
- Helping Clients Turn Problems into Opportunities
- Located in Fairfax, VA

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GBB's Waste Consulting Services

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

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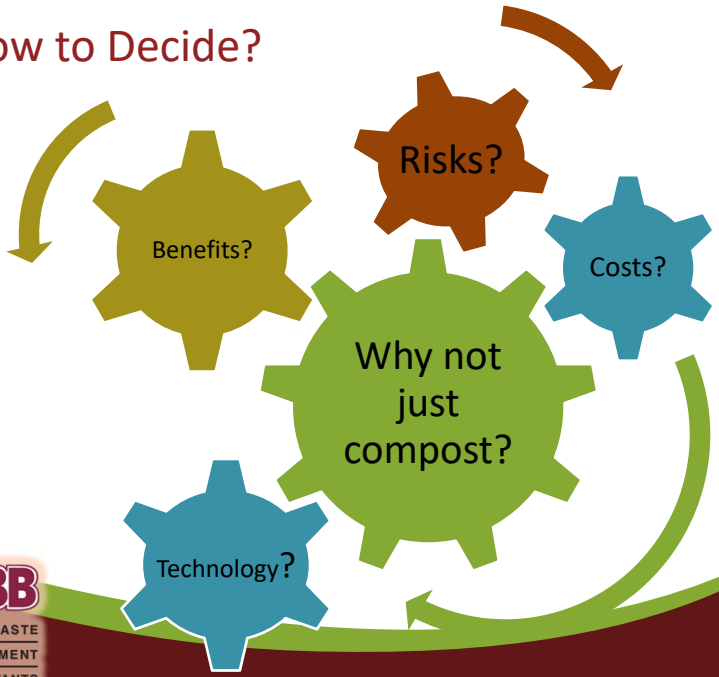
How to Decide?



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Anaerobic digestion

- Microbial decomposition of organic matter into methane, carbon dioxide, inorganic nutrients and non-digested organics in oxygen depleted environment and presence of the hydrogen gas.
- Complementary to composting
- Results in biogas/ electricity and Compost/soil amendment

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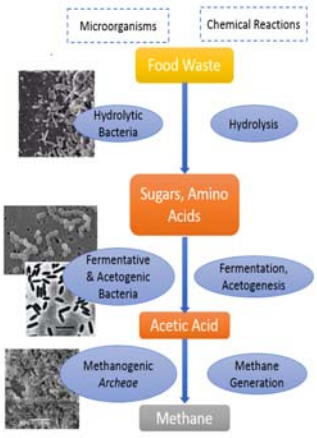
What is Anaerobic Digestion?

Anaerobic Digestion

Microbial decomposition of organic matter

Oxygen depleted environment

Methane, inorganic nutrients and non-digested organics



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Classification of AD Technologies I

Number of reactors in series

Single Stage
Feedstock → Anaerobic Digestion
- Hydrolysis
- Acid Forming
- Methane production

→ Products
- Biogas
- Digestate

Multi Stage
Feedstock → AD Stage I
- Hydrolysis
- Acid Forming

→ AD Stage II
- Methane production

→ Products
- Biogas
- Digestate

Operating Temperature

Thermophilic
(120- 150˚F)
Mesophilic
(70- 104˚F)

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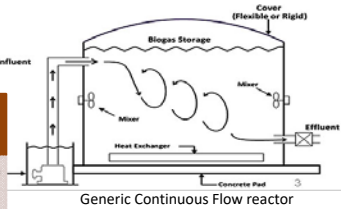
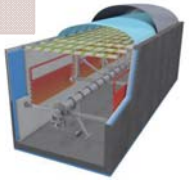
Classification of AD Technologies II

Feedstock Introduction
- Continuous flow
- Plug flow
- Batch



Generic Continuous Flow reactor

Solids Content
- Low Solids
  - Pumpable material ("wet")
  - <15% Solids content
- High Solids
  - 25-30%- pumpable ("wet")
  - >50%- stackable ("dry")



Eisenmann Plug Flow Reactor

Zero Waste Energy Batch reactors

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ANAEROBIC DIGESTION IMPLEMENTATION IN SOLID WASTE MANAGEMENT

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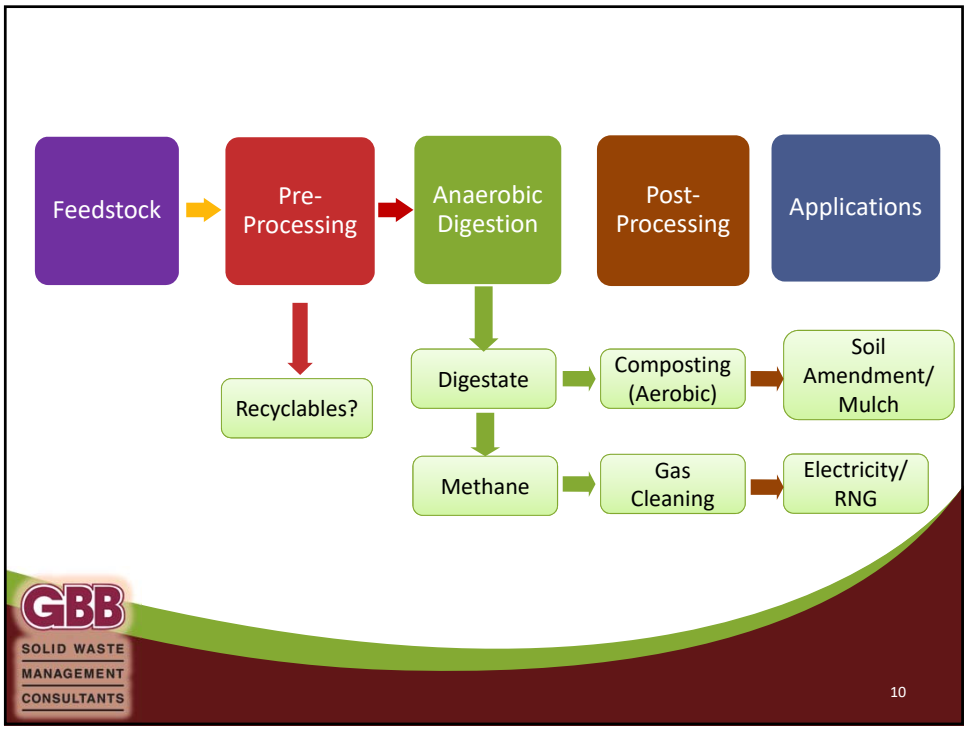

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AD Feedstocks

Feedstock

Other Sources for Organic Materials

Grocers | Restaurants and Cafeterias | Urban Farms | Food Processing Industries | Curbside Collections

Source: Getty Images

Source: Seattle Public Utilities

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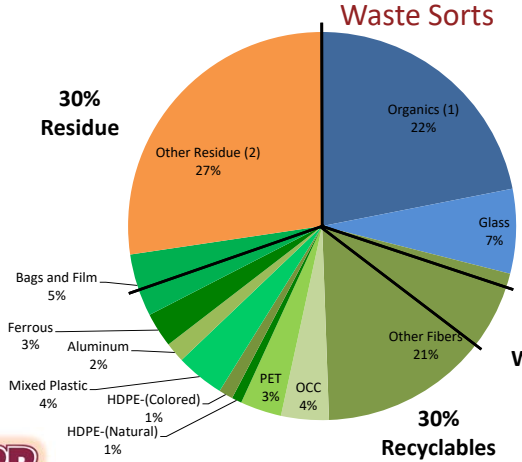
Municipal Solid Waste (MSW)

Feedstock

Residential MSW Composition from Actual Waste Sorts



30% Residue

30% Organics and Fines

10% Wildcard

30% Recyclables

Source: Compilation of Sort Data from Fayetteville, NC and Fort Worth, TX

(1) Contains Food Waste, Soiled Paper, and Yard Trimmings
(2) Includes C&D, Diapers, Textiles, Electronics and Other Residue

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Feedstock

Organics from MSW

- Requires Pre-Processing Equipment
- Can be an output from a Mixed Waste Processing Facility that can also recover recyclables
- Not as clean for re-use as Source Separated Organics

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Pre-Processing

Pre-Processing Organics for AD

- Pre-Processing for Wet Digestion
  - More Intensive to break down organic material, remove residue, and achieve the correct solids content (Processor Dependent)
- Pre-Processing for Dry Digestion
  - Source Separated may need yard waste mulch added to achieve stackability
  - MSW needs equipment to separate from other materials but can then be processed directly

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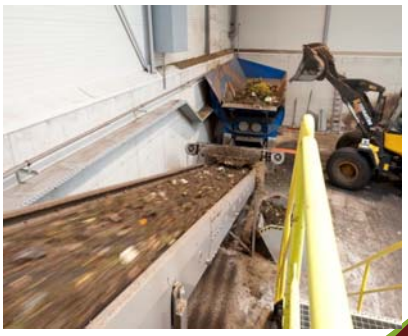
Pre-Processing

Pre-Processing of Feedstocks

Source Separated (Dry AD)

Source: GBB Visit to Zero Waste – Monterey, CA

Source Separated (Wet AD)



Source: Kompogas

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Pre-Processing

Pre-Processing of Feedstock

Mechanical Separation from MSW

Organic Fines After Screening

Prior to Loading in Bunkers (Dry)

Source: GBB Visit to Republic Newby Island /ZeroWaste San Jose

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Anaerobic Digestion

AD Process – Gas Production

Source: GBB Visit to ZeroWaste Monterey, CA

Source: GBB Visit to Quasar – Wooster, Ohio

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Anaerobic Digestion

AD Process –Digestate

Dry AD

Source: GBB Visit to Zero Waste – Monterey, CA

Wet AD

Source: Kompogas

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Post-Processing

Post-Processing of Digestate

- Wet Digestate
  - Requires dewatering and may need additional drying
- Dry Digestate
  - Screening (Separation by Size)
  - Air Classification (Separation by Weight)
  - Optical Units (NIR, X-Ray)

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Post-Processing

Processing of the Digestate

Some Equipment Used

Mobile Screen

Source: GBB Visit to Zero Waste – Monterey, CA

Densimetric Table

Source: Van Dyk

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Applications

Applications - Compost

Source Separated Organics

Maturing Windrows

Screened Final Compost

Source: GBB Visit to Zero Waste – Monterey, CA

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Applications

Applications – Soil Amendment

MSW Sourced Organics

Maturing Windrows

Screened Final Product

Source: GBB Visit to Zero Waste – San Jose, CA

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Applications – Methane Gas

Applications

IC Engine/Electricity and Heat

Source: GBB Visit to Zero Waste – Monterey, CA

Renewable Natural Gas (RNG)

Source: CleanEnergy

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ANAEROBIC DIGESTION IN THE US

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Technologies and Risk

Alternative	Risks/Liability	Risk Summary
Mass burn	Proven commercial technology	Very Low
Aerobic Composting	Proven commercial technology	Very 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

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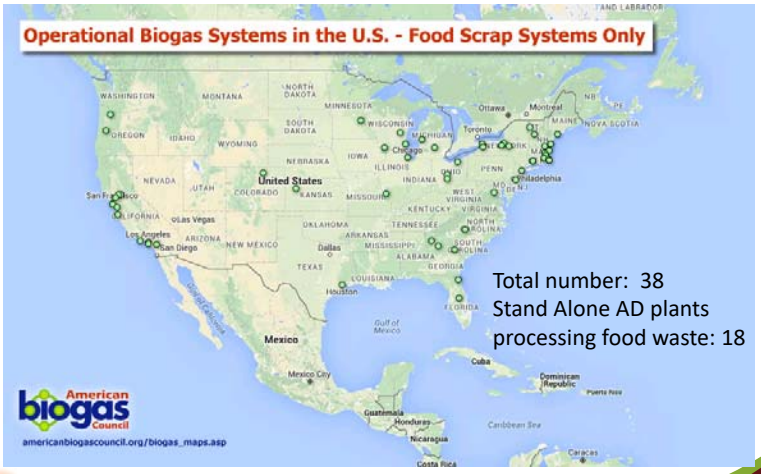
Operational Biogas Systems in the U.S. - Food Scrap Systems Only



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Facilities and Market Leaders

- Privately financed, owned and operated
- Commercial food waste
- Organics from MSW
- Mixed with yard waste

BIOFERM ENERGY SYSTEMS
VIESMANN Group
quasar energy group
Anaergia
KOMPOGAS
ZeroWaste ENERGY, LLC. Recovery and Energy with Zero Waste
OWS Organic Waste Systems
EISENMANN

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Projects Under Development & Construction

Total: 26
Under Development: 16
Under Construction 10

Yellow- under development
Green- Under construction

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System Economics

- Tipping fees at operating plants:
  - $40-$100/ton
  - Cleaner the feedstock lower the tipping fee
- Capital expenses
  - Different for different types of AD
  - $300-$500 per installed annual ton of capacity
- Operating Expenses
  - 2-3% of the Capital Expenses per ton processed

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Revenue Sources

- Electricity/ biogas sale
- Digestate/ fertilizer sale
- RINs
  - $0.90-$1.80/"gallon" (77,000 BTUs) for biogas>vehicle fuel
  - Types for biogas: D3 cellulosic advanced and D5 advanced
- Low Carbon Fuel Standard (LCFS), CA
  - Metric Tons of Carbon Dioxide equivalent (MTCO2e) avoided
  - $85-$100 per credit
- RECs (eligibility depends of the state)
  - $20/MWh – PJM value
- Production Tax Credit-
  - Section 45: Open/closed-loop Biomass (electricity)
    - 1.15 cents/kWh (x2 for closed loop)

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Capital Funding

- Investment Tax Credit-
  - Section 45: Open/closed-loop Biomass (electricity)
    - 30% of qualifying property (capital costs)
    - Must "commence construction," safe harbor 5% or complete "Physical work of a significant nature" by December 31, 2016
  - H.R.5489 — Agriculture Environmental Stewardship Act of 2016 (non-electricity)
    - 30% ITC for:
      - Non-Electricity Biogas Systems (heat, fuel)
      - Nutrient Recovery Systems
  - Loan Guaranteed
  - Private investment sources

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Drivers

- High recycling and diversion goals (up to 80%)
- Zero waste goals
- Food waste disposal bans/mandates-VT, CT, CA, MA and RI
- Recognition of the food waste as a feedstock for AD plants and biogas production
  - Biogas as a fuel from organic waste included in the RFS2 under advanced fuel qualifying for the D3/D5 RINs
- Financial support for infrastructure development
- Availability of private financing

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Trends

- From private initiatives to bigger involvement of the public sector
- More world leading technology developers coming to the US
- Wastewater treatment plants interested in using excess AD capacity for food waste
- Part of complex solutions for mixed waste processing (MBT concept)

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Questions and comments?

Thank you!

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