SCS ENGINEERS

Anaerobic Digestion Post-consumer Food Scraps

NEWMOA Webinar

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Overview

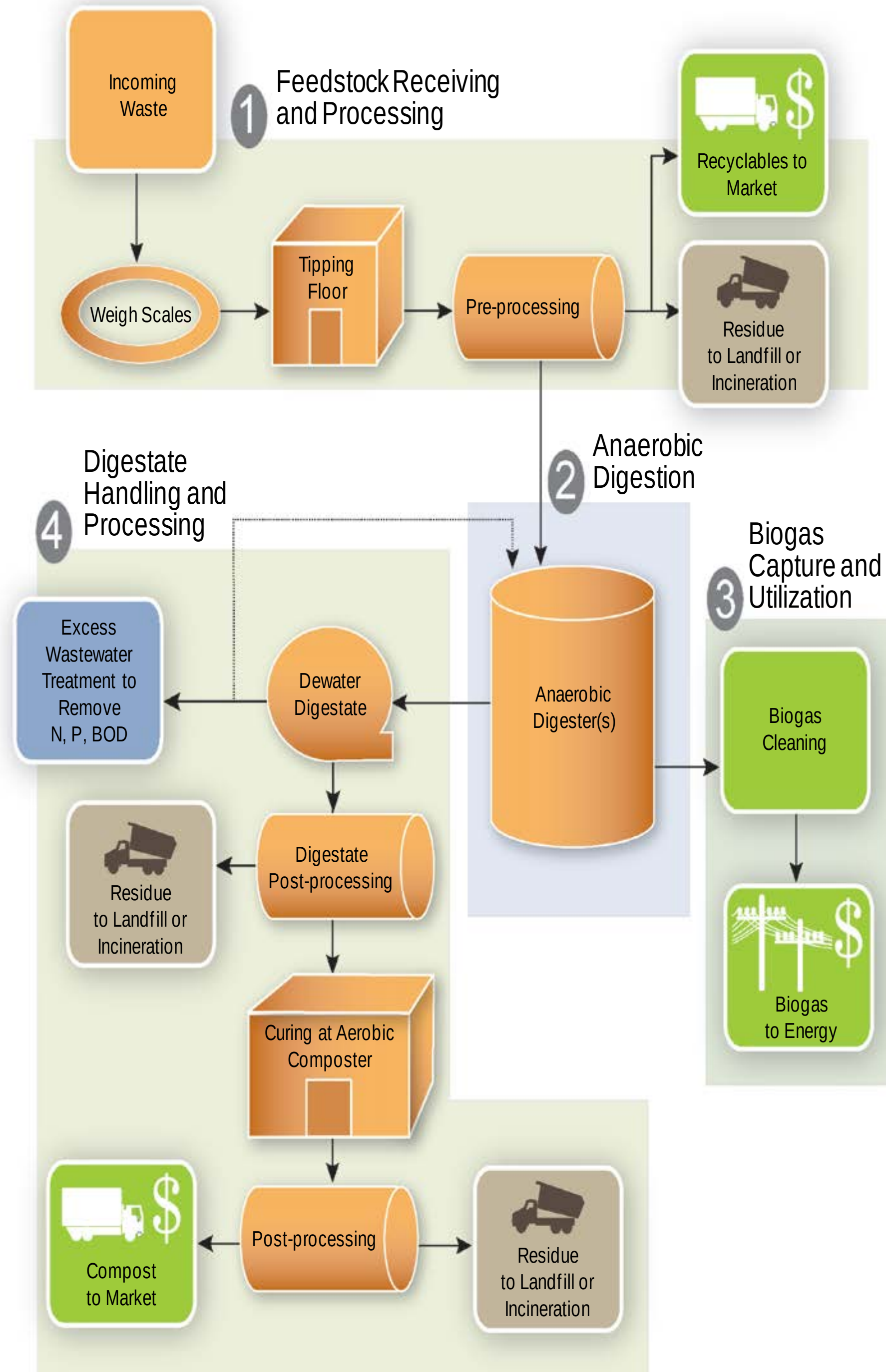
- Introduction
- AD technologies
- AD facilities
  - Operational
  - Construction/permitting
- Technical feasibility considerations
- Financial feasibility considerations

Introduction

- Tom Kraemer, CH2M
  - 32 years in solid waste management, recently focused on organics
- Greg McCarron
  - SCS Engineers – New York
  - 29 years in solid waste management, SCS National Expert on Organics Management
- Focus on post-consumer food scraps

AD PROCESS OVERVIEW

FEEDSTOCKS DRIVE EVERYTHING

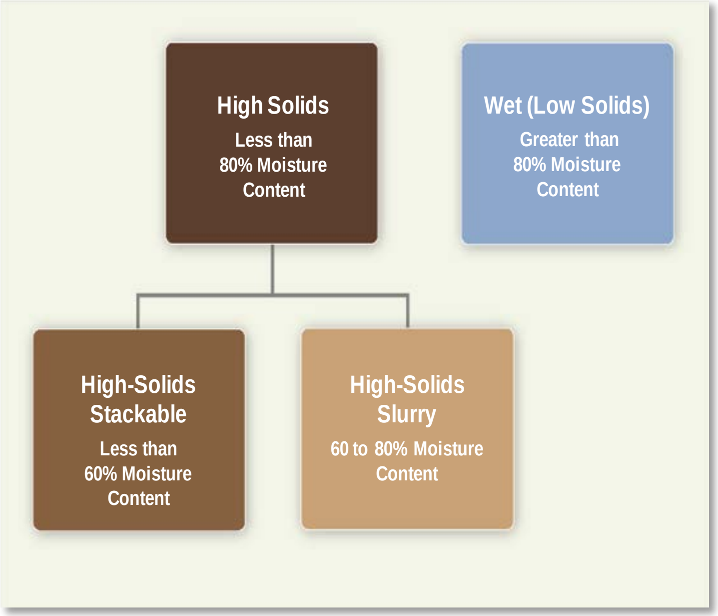


The Front End: Pre-Processing

- DON'T NEGLECT PRE-PROCESSING IN PLANNING THE PROJECT!
- Once the feedstocks have been inspected and unacceptable materials removed, they may need to be physically or chemically altered to provide optimal conditions for the digestion process.
- Common preparation steps includes grinding or shredding, and water addition.
- The level and type of preprocessing and preparation required is dependent on the feedstock and also on the specific AD technology used.
- Starter inoculums (e.g., recycled feedstock that has already gone through the digestion process or wastewater produced during digestate dewatering or percolation steps) might be added to initiate microbial activity at the mixing stage.

The AD Process: The Basic Technologies

- ***Wet digesters*** are designed to handle materials that are dissolved or suspended in water.
- In ***High-solids digesters***, the materials are either pumped into a digester tank as a slurry or stacked in place (e.g. with front-end loaders). When stacked in place, water is percolated through the materials to distribute nutrients and microorganisms; they are not submerged in a tank.



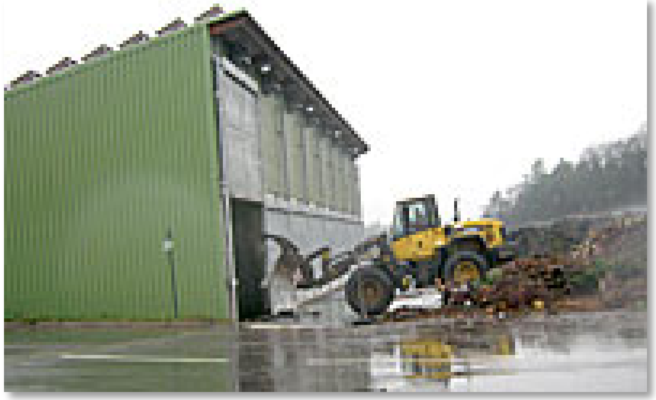
- Digesters can be designed to operate in **thermophilic, mesophilic and psychrophilic** temperature ranges.
- Systems can have **multiple stages**. In single-stage systems, the entire biological digestion process taking place in a single vessel. In two-stage systems, hydrolysis occurs in one vessel and the subsequent stages occur in a different vessel. The vessels are optimized for the stage`s microorganisms.

Types of Anaerobic Digestion for Food Waste

- Wet AD
- High Solids AD
- Co-digestion with sewage sludge

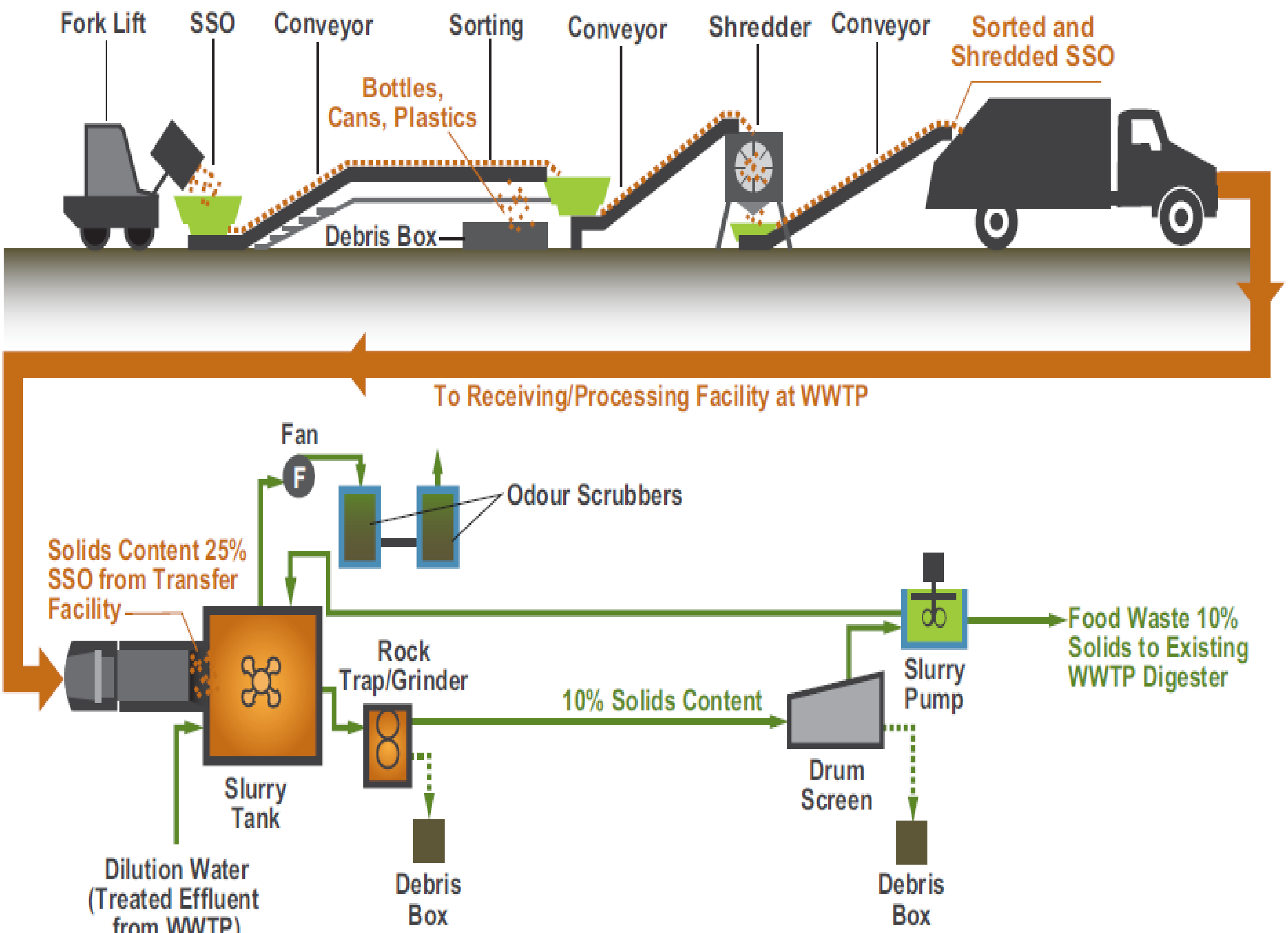
Wet Digester

Wastewater treatment plant digester



High Solids AD

Co-Digestion in WW Sludge Digester



Digester Type by Moisture Content

Digester Type	Digester Water Content	Feedstock Type	Net Energy Output	Digestate Treatment	Leachate Production
High solids stackable	Less than 60%	Stackable materials	Highest	Dewatering not required	Lowest
High solids slurry	Between 60% and 80%	Wet but not liquid	Intermediate	Dewatering may be required	Intermediate
Wet	Greater than 80%	Liquid	Lowest	Dewatering is required	Highest

The Back End: Digestate Management

- DON'T NEGLECT THE BACK END! 80 - 90% OF THE INPUT TONNAGE BY WEIGHT COMES OUT THE BACK END
- Digestate is the solid or semi-solid material left over at the end of the digestion process.
- In wet (low-solids) and high-solids-slurry digestion systems, the digestate is the solid or semi-solid material extracted from the bottom of the digestion tanks. In high-solids-stackable digestion systems, digestate is the solid material removed from the digestion tunnels.
- A typical quantity of digestate for all digester types is 0.85 ton of dewatered digestate for each ton of wet SSO added to the digester.
- It is important to estimate digestate quantities, dewatering requirements (if any), and how much centrate will be generated from dewatering operations.
- Digestate is typically composted, but is sometimes land applied.

Wet AD: Pros and Cons

Advantages	Disadvantages
• Handles wastes that are in a liquid or slurry condition upon arrival • Entirely contained system (high level of odour control)	• Cannot generally handle waste with contaminant material (e.g., plastic, metals, and rocks) • Requires significant pretreatment and operational care to avoid exceeding capacity or upsetting biosolids digestion • Produces more effluent than the other two digester types • Requires more energy consumption than high-solids digesters

High-Solids Slurry: Pros and Cons

Advantages	Disadvantages
• Can process waste with contaminants (e.g., plastic, metals, and rocks) • Handles wastes that are in a liquid or slurry condition upon arrival • Produces less effluent than wet (low-solids) digestion • More energy-efficient than wet (low-solids) systems • Entirely contained system (high level of odour control)	• Slurry typically is not completely mixed, so can cause uneven digestion if not carefully managed • Produces more effluent than high-solids-stackable digestion • Less energy-efficient than high-solids-stackable digestion • May require water addition to make the feedstocks pumpable

High-Solids Stackable: Pros and Cons

Advantages	Disadvantages
• Can process waste with contaminant material (plastic, metals, rocks) • Handles solid stackable wastes with little pretreatment • Produces negligible effluents • More energy efficient than other AD systems • May require no water addition	• Requires mixing with shredded L&YW or other bulking materials • Must operate as a batch system, requiring purging and opening the digester between batches • Odour potential when door is opened

Operational AD Facilities

- EREF Study, August 2015
  - Study focus on organic fraction of MSW (OFMSW); includes data as of 2013
  - 25 stand-alone AD facilities for OFMSW
  - 75 AD facilities at farms; co-digest OFMSW
  - 81 AD facilities at WWTP; co-digest OFMSW
  - 800,000 tons of OFMSW processed
- Update of EREF Data to Fall 2015
  - 5 additional AD facilities are operational
  - 2 additional AD facilities are in construction

Operational Facilities in the NEWMOA States

- New York: Stand-alone facilities (EREF)
  - Buffalo BioEnergy: quasar wet system; biosolids/ FOG/manure/food; 40k tpy; 770 kW
  - Niagara BioEnergy: sister plant
- MA: Stand-alone facilities (EREF)
  - Agreen: quasar wet system; manure and liquid food; 15k tpy; 250 kW
  - BGreen: sister plant
- NEWMOA region (EREF)
  - On farm: 17
  - WWTP: 6

Construction/Permitting NEWMOA States

- Construction
  - RI, BlueSphere: wet; food scraps; 250 tpd; 3.2 MW
  - MA, Stop & Shop: wet; food scraps; 35k tpy; 1.25 MW (secure feedstock and energy use)
- Permitting
  - CT, Anaergia/Bridgeport: wet; food/ biosolids/FOG; 10k tpy; 1.6 MW
  - MA, Harvest/Bourne: food scraps/biosolids; 5 MW

Notable West Coast Facilities

PRIVATE SECTOR "MERCHANT" FACILITIES:

- Harvest Power's Energy Garden and Composting Facility in Richmond, BC
  - 20,000 tpy commercial food waste – high solids stackable - biogas to electric
- JC Biomethane in Eugene, Oregon
  - 12,000 tpy commercial food waste
  - 16,0000 tpy food processing waste and manure– wet digester – biogas to electric
- CR&R Digester – Perris CA
  - 80,000 tpy commercial food and yard waste – high solids slurry – biogas to CNG

PUBLIC SECTOR FACILITIES

- San Jose HSAD Facility
  - 90,000 tpy organics from "wet/dry" ICI waste collection system – high solids stackable
- Marin County Co-digestion
  - 4,000 tpy municipal food scraps – biogas to electricity

Technical Feasibility Considerations

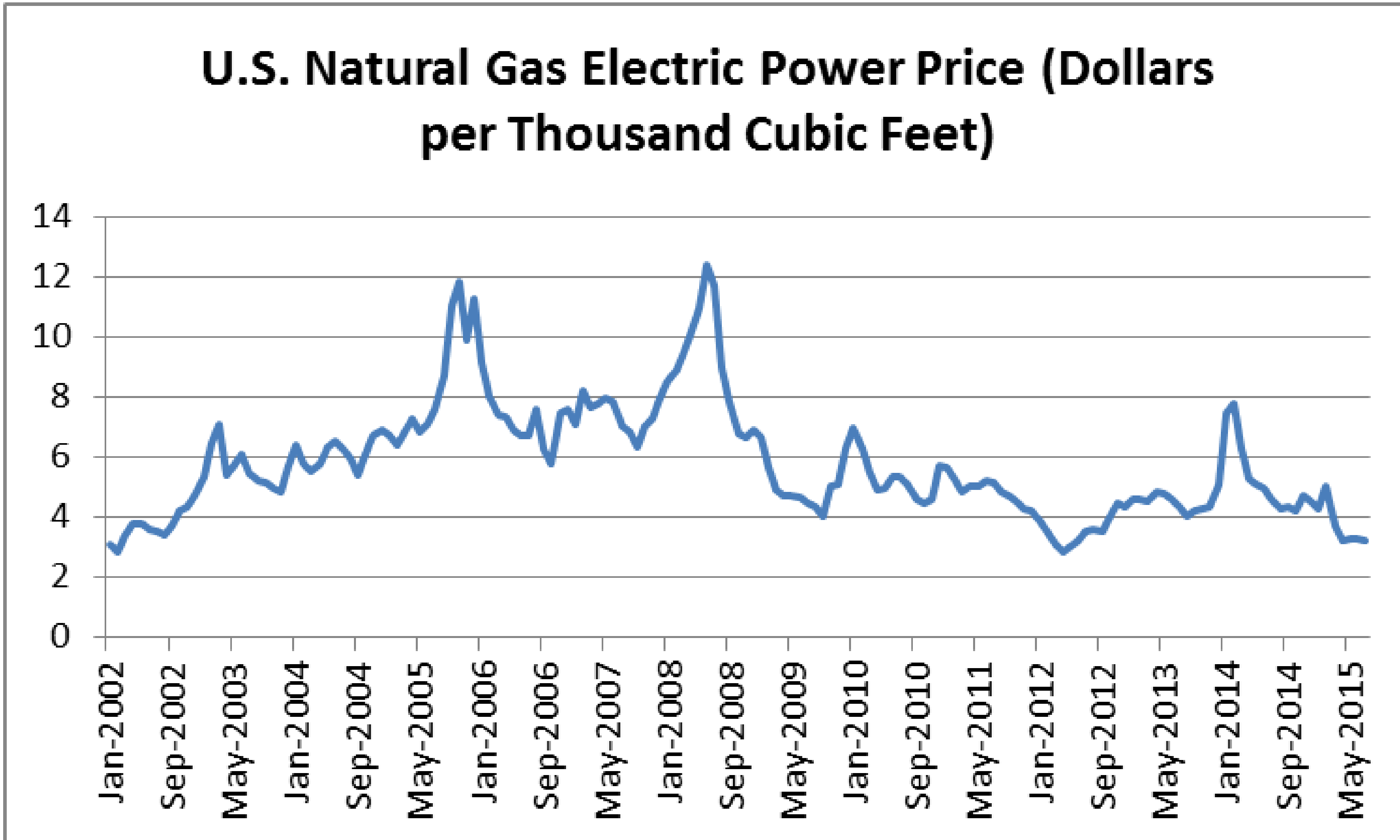
- Feedstock (see next slide)
- Technology
  - Pre-processing equipment
  - Digester equipment
  - Biogas processing and use
- Permitting requirements and timeline
- Digestate management and quality
- Contracts for construction and operation
- Developer and vendor guarantees
  - Throughput and energy

Feedstock Considerations

- Quantity
  - Tonnage available in service area?
  - Seasonality of feedstocks (e.g., leaves)?
  - Competing facilities?
- Quality
  - Contamination: plastic, grit
  - Effect on digester equipment
  - Effect on digestate processing and use

Financial Feasibility Considerations

- Tipping fee revenue
  - What is the competition in the service area?
  - How will feedstock be secured?
- Energy revenue
  - What is the energy product?
  - Preferred: offset or provide power on-site (e.g., WWTP/farm/factory)
  - Electric to the grid: price is usually set by natural gas price (see next slide)
  - RECs
- Grants and subsidies


U.S. Natural Gas Electric Power Price (Dollars per Thousand Cubic Feet)
14
12
10
8
6
4
2
0
Jan-2002
Sep-2002
May-2003
Jan-2004
Sep-2004
May-2005
Jan-2006
Sep-2006
May-2007
Jan-2008
Sep-2008
May-2009
Jan-2010
Sep-2010
May-2011
Jan-2012
Sep-2012
May-2013
Jan-2014
Sep-2014
May-2015

Costs

- Project-specific cost estimate needed
  - Limited facilities processing OFMSW vs. farm or WWTP digesters
- Capital costs
  - Pre-processing system
  - Digester system
  - Biogas system
- Operating costs
  - Equipment O&M
  - Digestate management

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