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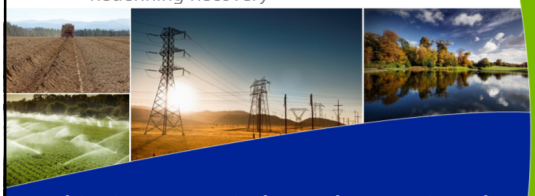
Redefining Recovery



Achieving power independence using ultra low emission onsite power generation

NJWEA Annual Conference, Atlantic City, NJ

May 14, 2013

Deo Phagoo, P.Eng.
VP Municipal Sales

Outline

- Why Power Independence?
- Co-digestion + Cogeneration
- Ultra Low Emission Case Study

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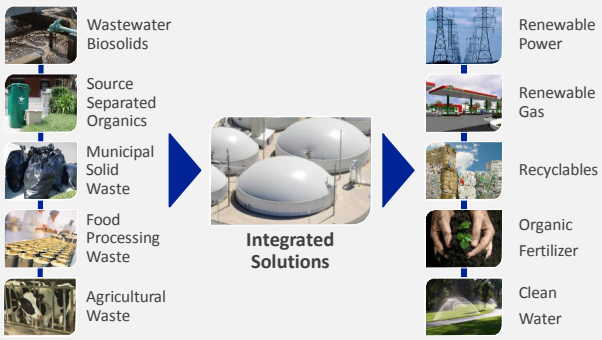
Our Vision: Zero Organic Waste Future



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Why Power Independence?

We Live in a World with Inefficient Wastewater Treatment

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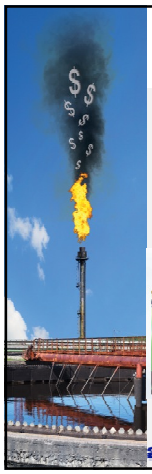
We Live in a World With Too Much Waste

Anaergia Sources: Adapted from UNEP, BCC Research, EPA, J.W. Levis, IMF, ITAU

Anaerobic Digestion Technology

- Digestion has not evolved significantly in 30 years
- AD is the forgotten unit process in the WWT industry
- Municipal digesters are the largest underutilized municipal asset in age of renewable energy and organics diversion
- Wasted tank infrastructure operating at low solids content and low OLR

Achieving Power Independence



Resources should not be wasted

Sludge + Organic Waste = ENERGY!

Typical Organic Waste Reception

Solid Organic Waste
- Restaurant Waste
- Grocer Waste
- Municipal Green Bin Programs
- Food Processing Waste

Liquid Organic Wastes
- Food Processing Wastewater
- Industrial Biosolids
- Oils, Glycerin, etc

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Typical Biogas Potential by Waste Source

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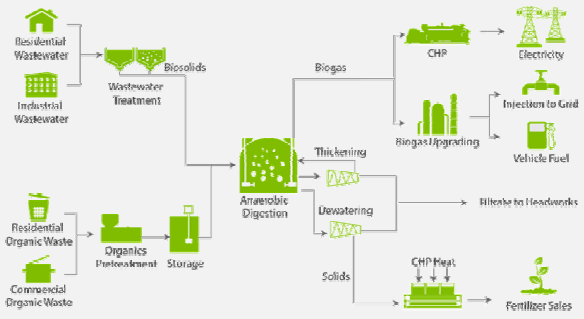
Source: Microbiological Handbook for Biogas Plants, Swedish Waste Management U2009:03, Swedish Gas Centre Report

AD = Center of Organic Waste Processing



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How to Achieve Power Independence?

Anaergia's Omnivore AD

High solids anaerobic digestion system for

- Sewage sludge only or co-digestion of sewage sludge with:
  - FOG or brown grease
  - Pre and post consumer food waste (Green Bin)
  - Food processing industry waste
- Existing digester retrofit to increase capacity
- New digesters - reduce volume/installed cost

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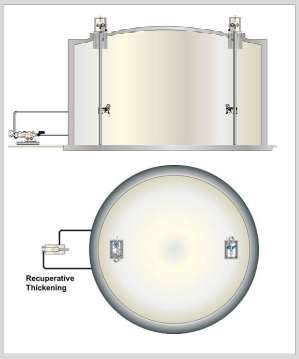
Overview of Omnivore Digester



Primary Design Function
- Retrofit for Existing WWTP Digesters

Substrates
- WWTP Sludge
- FOG & SSO
- Industrial Food Processing Waste

Design Features
- Digester Retrofit
- Recuperative Thickening
- Hydraulic High Solids Mixing
- Substrate Receiving Station
- Gas Cleaning and CHP
- Biosolids Handling

Benefits
- Increase digester capacity
- Co-digestion
- Increase biogas production
- Heat & Power Production
- Tipping fee Revenue

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Omnivore Principles

- Decouple HRT from SRT removing from digester more water than solids
- Increase SRT 2 to 3 times for improved VSR >60% on combined sewage sludge
- Extend SRT with recuperative or pre thickening
- As digester solids content increases improve mixing to handle higher viscosity sludge
- A well operated digester with long SRT and high bacterial biomass inventory achieves similar VSR than complex and energy intensive thermal hydrolysis or other WAS pre-treatment methods

Hydraulic Mixers

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Hydraulic Power Unit

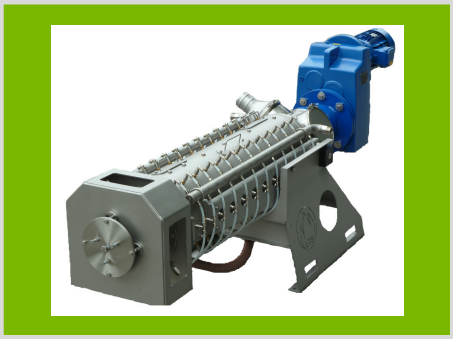
May 13 18

Service Box



19

Solids Separator



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CHP Technologies

IC Engines
Up to 5 MW
30-40% efficiency
Proven Technology
Higher Emissions

Micro Turbines
Up to 250 kW
25% efficiency
Limited experience with DG
Low Emissions

Gas Engines
>3 MW
25-35 efficiency
Limited experience with DG
Higher Emissions

Fuel Cells
Up to 2.8 MW
Up to 47% efficiency
New Technology for DG
Ultra Low Emissions

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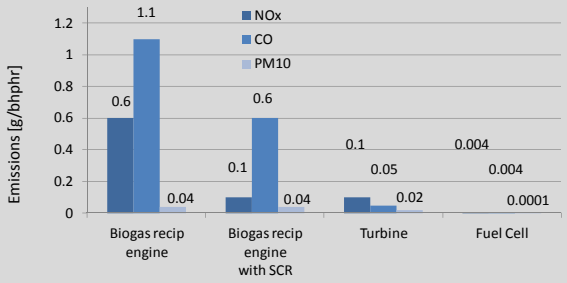
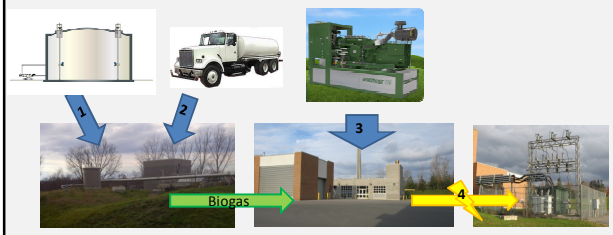
Emissions from CHP using Biogas



The Solution

Omnivore Upgrade to WWTP



1 Retrofit Digester with Omnivore Equipment
2 Bring in External Waste
3 Convert Biogas to Electricity through new CHP
4 Send Electricity to WWTP & Grid

Goal = Power Independent WWTP

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Fuel Cell Case Study

City of San Jose WWTP

City issued RFP in 2009 for Fuel Cell Power Plant

- DBOOF with PPA

Project awarded to UTS BioEnergy (now Anaergia) in 2010 for DBOOF

- Design in late 2010
- Construction 2011
- Start-up/Commissioning 2012

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Why Fuel Cells?

Highest efficiency for CHP

- Electrical efficiency up to 47%
- Nearly constant over 50 – 100% load

Minimal air permit requirement – ultra-low emissions

Minimal noise

Higher availability

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Why Fuel Cells? – Other Drivers

Qualifies for simplified interconnection

2012 California SGIP grant

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DBOOF - Input Requirements

Supply Agreements

- **20** year for primary substrates
- **5+** year for co-digestion substrates
- Substrate quality requirements

Predefined Rates

- Tipping Fees
- Escalation Rate

} Below Typical Market Costs

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DBOOF - Output Requirements

Purchase Agreements

- **20** year power purchase agreement
- **5+** year agreements for co-products

Predefined Rates

- Power Prices
- Co-product prices
- Escalation Rate

} Below Typical Market Costs

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Partnership Arrangement

City Provides

- Untreated digester gas at approx. 65 psig to the edge of equipment pad
- City water and drainage

Anaergia Provides

- Electricity at a fixed contracted price to nearby plant switchgear
- Hot water at 180 deg F for plant hot water heating system

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Fuel Cell CHP

San Jose, California

Feed: Wastewater Sludge Biogas to Fuel Cell CHP, 167 MGD Facility

Energy Output: 1.4 MWe

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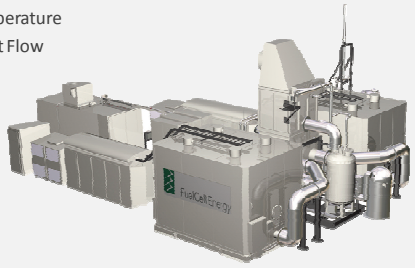
Fuel Cell Utilized

Fuel Cell Module Characteristics

- 47% Electrical Efficiency
- 13,800 V Output
- 700°F Exhaust Temperature
- 36,600 lb/h Exhaust Flow
- 72 dB at 10ft



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Gas Treatment System

Regenerating system was selected to reduce O&M costs associated with media replacement of traditional systems

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Operation

Fuel cell average availability

- 90.8% for 10 months including 2 major repairs
- 95.3% excluding Aug 2012 stack replacement

Digester gas treatment system average

- 97.7% for 10 months
- 99.1% recent 9 months after equipment testing

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Lessons Learned – FC vs IC Engine

- Starting from cold takes several days
- Load change is slower
- Less heat is available but more power
- Higher capital costs
- Higher maintenance costs (mainly due to stack replacement)
- Gas quality is very critical for successful operaiton

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Inland Empire California

Inland Empire, California

Feed: Wastewater Sludge Biogas to Fuel Cell CHP, 44MGD Facility

Energy Output: 2.8MWe, 1.3 MWth

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Take Away

- Landfill diversion + Co-digestion to reduce GHG and increase biogas production
- Omnivore AD to increase capacity of existing digesters
- Co-digestion + Omnivore = Net Zero
- Full Cell CHP = Ultra Low Emission

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Thank You

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