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# Small-Scale Organics-to-Energy Vendor Directory

June 28, 2013

Prepared for:



Prepared by:  
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Lexington, MA

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## Introduction

The Commonwealth of Massachusetts has set a goal to reduce the amount of organic material that is disposed of through landfilling and incineration by 350,000 tons annually by 2020. At the same time, it seeks to promote the generation of more renewable energy from source-separated organic feedstocks. The application of organics-to-energy technologies helps to achieve both of these goals. For the purposes of this compendium, organics-to-energy technologies include:

- Wet anaerobic digestion for feedstocks less than 20 percent solids;
- Dry anaerobic digestion for feedstocks greater than 20 percent solids; and
- Composting systems that generate heat and make it available for use.

Anaerobic digestion (AD) and composting are both processes by which microorganisms decompose organic matter. AD occurs in the absence of oxygen whereas composting may occur with or without oxygen. Biogas produced as a product of AD can be used for heating and/or generating electricity; heat produced as a product of AD or composting can be used in a variety of thermal applications.

For additional information about AD, composting, or biogas, please visit the [AgSTAR Program website](#), the [U.S. Composting Council website](#), or the [American Biogas Council website](#).

The Massachusetts Clean Energy Center (MassCEC), in consultation with the Massachusetts Department of Environmental Protection and the Massachusetts Department of Agricultural Resources, sought to fill an existing data gap for information on relatively small organics-to-energy systems. This document, produced by MassCEC and their contactor Eastern Research Group, Inc. (ERG) is based on publicly available technology information and information collection directly from vendors. Information provided was not verified. The document is intended to introduce potential users to some of the options currently on the market and to help them identify systems that may be applicable to their organics management needs.

As a companion to this document, ERG developed a spreadsheet-based Small-Scale AD Economic Feasibility Screening Tool (“the Tool”) to help potential users of these systems perform preliminary economic feasibility assessments of the systems for their particular applications. Some of the system vendors included in this Directory did not provide enough information to perform a preliminary economic feasibility assessment and were therefore excluded from the Tool. The systems included in the Tool are noted in Table 1. More information about the Tool is available in the companion document entitled, “Economic Assessment of Small Anaerobic Digestion Systems for Three Scenarios.”

## Technology Assessment Forms

To be included in the analysis, the technologies were required to be available on the market, have vendor support available in the U.S.,<sup>1</sup> and be suitable for use by small farms, individual food waste generators, small community systems and others with available feedstocks in the range of 0.5 to 30 tons per day. Technologies with decreased functionality in colder climates<sup>2</sup> or which were primarily designed for woody biomass were excluded. Also, a focus was placed on modular systems and systems that are

<sup>1</sup> Foreign companies without U.S. distributors were eliminated due to difficulty resolving pre- and post-construction problems.

<sup>2</sup> Examples include covered lagoons and tubular or fixed dome digesters; these systems function best in locations with warmer ambient temperatures than Massachusetts.

appropriate for food waste. While best efforts were made to contact domestic and international businesses with relevant technologies, budget limitations and lack of response by project deadlines means the technology list provided is not exhaustive. Promising prototypes of additional technologies exist, but this assessment excluded systems without operational projects.

The goal of this directory is to enable entities managing organic materials to screen systems that may be suitable for their operations and identify which technologies may be worthy of further in-depth study for their particular applications. The technologies evaluated in this document are described in Table 1.

Note that the information included in this document is only intended as an introduction to each technology and for identification of systems that are potentially suitable for a user's needs. Specific operating values for any system may vary significantly depending on a variety of factors including the feedstock, pretreatment, and operation and maintenance. To receive more detailed information, contact system manufacturers directly.

MassCEC and ERG thank the technology vendors for their cooperation and participation in this process.

**Table 1. Small-Scale Organics-to-Energy Technologies**

Technology	System Type	Size Range	Accepted Feedstock	Operating Type	Structure
Agrilab Technologies, LLC's Isobar Heat Recovery Unit	Batch vessel, static pile, or windrow composting	1.6 tons/day* or greater	Manure, food waste, organic matter, yard waste, agricultural biomass	Batch or Continuous	Modular
Avatar Energy's Mixed Plug-Flow Digester**	Plug-flow mesophilic anaerobic digestion	2.6 to 92 tons/day*	Manure, food waste, organic matter, yard waste, fats, oils and greases	Continuous	Modular
BIOFerm Energy System's COCCUS**	Complete mix anaerobic digestion	30 tons/day	Manure, food waste, organic matter, yard waste, other organic wastes	Continuous	Constructed onsite
BIOFerm Energy System's EUCOLino**	Plug-flow mesophilic anaerobic digestion	7.5 to 15 tons/day	Manure, food waste, organic matter, yard waste, other organic wastes	Continuous	Modular
CH Four Biogas's Mixed-Substrate Anaerobic Digestion**	Mixed mesophilic anaerobic digestion	10 to 150 tons/day	Manure, food waste, septage	Continuous	Constructed onsite
Organic Waste System's DRANCO and DRANCO-FARM	Vertical plug-flow, thermophilic anaerobic digestion with partial recycle	Up to 180 tons/day	Manure, food waste, organic matter, yard waste, other organic waste like crop residues, soiled paper, cardboard and ICI sludges	Continuous	Modular or constructed onsite
powerQUBE	Mixed mesophilic anaerobic digestion	Varies by feedstock, smallest system accepts 3.99 tons of food/day or 0.13 tons of fats and oils/day	Manure, food waste, organic matter, yard waste, other organic wastes	Continuous	Modular
SEaB Energy's Muckbuster**	Mixed mesophilic anaerobic digestion	0.55 to 11 tons/day	Manure, food waste, organic matter, yard waste, chipped wood	Continuous	Modular
Spectrum BioEnergy's BioBeetle	Mixed mesophilic anaerobic digestion	0.5 to 5 tons/day	Manure, food waste, organic matter	Continuous	Modular
Zero Waste Energy's SmartFerm	Mixed mesophilic and thermophilic anaerobic digestion	11 to 55 tons/day	Manure, food waste, organic matter, yard waste, other organic wastes	Batch	Modular

\* Calculated from vendor data assuming a waste density of 60 lbs/ft<sup>3</sup>

\*\* Vendor data are included in the Small-Scale AD Economic Feasibility Screening Tool.



**TECHNOLOGY REVIEW PERFORMED BY:**

Eastern Research Group, Inc. SM  
 Work Order 13-1 to Mass CEC  
 Date Completed: 3/18/13

**Organics-To-Energy Small Technologies Evaluation Form**

**GENERAL INFORMATION**

Name of technology: Isobar® Heat Recovery Unit

Vendor/brand name(s): Agrilab Technologies, LLC

Type of technology:  Composting     Dry AD     Slurry/Wet AD

Process: Process can be batch vessel, static pile, or windrow composting.

Vendor description of technology: The system extracts energy from the hot water vapor generated during composting. The system then transfers that energy via heat exchangers into an insulated bulk storage water tank for heating and process water applications.

**SUITABLE APPLICATIONS**

- Capped Landfills
- Operating Landfill
- Urban Settings
- Small Farm
- Co-Located with Composting Operation
- Food Manufacturer
- Institutional/Campus
- Other: Leaf and yard waste.

**REACTOR DETAILS**

Operating volume: > 54 ft<sup>3</sup>

Processing capacity: > 54  ft<sup>3</sup>/day

Retention time: Depends on process. Can range from 3 days (in-vessel) to 20-26 weeks (static pile)

Operating type:  Batch or  Continuous

For composting, recoverable heat at maximum processing capacity: 1,000Btu/hour/active ton of aerated compost = 5 million Btu/ton input

Footprint: 20ft, 30ft, 42ft long systems x 3ft wide (also custom sizes).

Physical structure:  Prefabricated (modular) or  Constructed onsite

Describe: Composting pile and storage unit. Structure and size of composting pile can vary in size depending on the process. Storage unit systems are adaptable to space constraints on-site. Pre-fabricated units may require some site work to install negative aeration systems.

## HOST FACILITY REQUIREMENTS

Describe structural requirements (e.g., a concrete pad for prefabricated systems):

Typically, systems are set in mechanical rooms (or elsewhere on concrete floors), but that is not a requirement. Units only require level ground.

	Yes	No	Describe
Utility connections			
Electrical interconnection to the grid	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Single-phase. Energy consumption is limited to 0.25 HP fans and small circulator pumps used to circulate water from exchange tank.
Water supply	<input checked="" type="checkbox"/>	<input type="checkbox"/>	On a daily basis, water supply is not necessary, but water is needed at start to fill system. Water may also be required for sanitation and cleaning or other processes.
Sewer connection	<input type="checkbox"/>	<input type="checkbox"/>	Not for all situations. In a municipal setting, yes; need a means to handle the condensate/leachates. However, all currently active sites are on farms and are using materials in farm processes (do not require sewer connection).
Operational equipment necessary, but not included (e.g. solids separator)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	If a farm site had exclusively liquid manure, a mechanical separator would be necessary.
Buildings and structures required for equipment and operations	<input type="checkbox"/>	<input type="checkbox"/>	No buildings/structures required, but having an indoor setting of some kind makes process control easier.
Other outdoor area required for operations (e.g. containment pond)	<input type="checkbox"/>	<input type="checkbox"/>	No requirements for system; some state/local composting rules may mandate specific operations.

## BIOGAS UTILIZATION

Equipment included?	N/A. System is a thermal energy capture system and does not utilize biogas.		
Interconnect switching included?	_____		
Type of biogas processing (e.g. drying, H <sub>2</sub> S scrubbing):	_____		
Engine-generator set make/model:	_____	Efficiency	_____ %
Capacity (kW), voltage, and single or three phase:	_____		
Non-electrical use:	_____		

## FEEDSTOCK

Minimum and maximum inputs:	average of 1, minimum	<input checked="" type="checkbox"/> tons per day	<input type="checkbox"/> tons per year
Acceptable moisture content	50-70% (65% is ideal)		
Pretreatment required?	<input type="checkbox"/> no <input type="checkbox"/> If yes, Describe: Depends on feedstocks. Agrilab can help determine whether pretreatment is necessary and, if so, what materials to blend with primary feedstocks.		

## FEEDSTOCK

Acceptable for System	Type of Feedstock	Predicted Volume Reduction, %
<input checked="" type="checkbox"/>	Livestock manure (3 to 10% total solids)	%
<input checked="" type="checkbox"/>	Livestock manure (>10% total solids)	%
<input checked="" type="checkbox"/>	Food wastes	%
<input checked="" type="checkbox"/>	Organic matter separated from municipal solid wastes	%
<input checked="" type="checkbox"/>	Non-woody yard wastes	%
<input checked="" type="checkbox"/>	Other organic wastes: Agricultural biomass	%

Comments: It's recommended to include small amount of wood chips in feedstocks to achieve optimal porosity for aeration. However, wood chips are not required.

Compost is generally a blend of various feedstocks (including separated anaerobic digestate). Volume reduction is typically 50% or more when blended.

## OUTPUT / DIGESTATE

Required holding capacity: Comment: 1,000-1,500 gallon tank to hold condensation. Standard septic system tank.

Type of Digestate	Quantity	Characteristics	Uses/Disposal Options
Liquid			
Solid	365-3,000 tons per ton input or ft <sup>3</sup> per ft <sup>3</sup> input		Compost can be made available for retail or used on-site.
Combined Liquid/Solid	365-3,000 tons per ton input or ft <sup>3</sup> per ft <sup>3</sup> input		Compost can be made available for retail or used on-site.

## OPERATION AND MAINTENANCE REQUIREMENTS

	Hours per week (if known)			Comment
	Low	Medium	High	
Operator expertise	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Most of needed operator expertise is related to composting skills. Expertise requirements are low for heat exchanger system itself.
Seasonal Issues	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Depends whether facility is under cover. Cold and snow can impact the composting process.
Labor				
Receiving	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Process control is important in commercial sites in order to handle odor, but is less of an issue at farms, which are generally located in less urban areas.
Loading	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Unloading	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Storage	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Curing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Pretreatment	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Typically low, except in cases of high-odor materials.
Mixing	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Blend needs to be homogenized to maximum extent possible.
Process monitoring	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Requires less than anaerobic digestion, but process monitoring is important during startup.



## OPERATION AND MAINTENANCE REQUIREMENTS

	Low	Medium	High	Hours per week (if known)	Comment
Engine and generator set maintenance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		N/A
Biogas processing equipment maintenance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		N/A
Residue management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		No residues. System produces heat with composted mulch as co-product.
Further processing of gas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		N/A
Further processing of digestate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		N/A
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Relative to anaerobic digestion, O&M requires much less management/supervision.
<b>Total Labor Per Week (sum of above):</b>				2 hr	

## POTENTIAL NUISANCE CONCERNS AND MITIGATION MEASURES

	Low	Medium	High	Description of Nuisance	Mitigation Measures
Odors	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Specific to sites in urban settings.	Sites with odor concerns can use negative aeration to filter out objectionable odors from the compost pile. Running those vapors through a heat exchanger first can help to improve biofilter performance.
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

## SYSTEM EXPENSES

Capital costs:	<u>\$ 25,000</u>	Cost for routine maintenance and supplies:	<u>\$ 400-800 per year</u>
Brief description of costs above (what size system was assumed, what equipment is included, etc)	Complete systems can range in price depending on whether or not there is a composting system already in place (depending on size and level of retrofits needed, can be as high as \$2 million). Cost varies based on system size, and the price estimate provided above is for a 20 ft Isobar heat exchange unit and assumes that there is already a composting system in place. System includes Isobars, housing, heat exchange tank, 1/8 HP inline blower, exhaust stack, and insulation.		
Shipping and installation:	\$ 2,000-20,000 (depends on level of technical assistance needed)	Dealer service call cost:	\$
Warranty availability and features (if available):	5-10 years	Warranty cost (if available):	\$
Expected life of systems	20 years		
Financing options offered:	<input checked="" type="checkbox"/> Lease	<input checked="" type="checkbox"/> Buy	<input type="checkbox"/> Other: _____

## VENDOR INFORMATION

System manufacturer:      Name: Agrilab Technologies, LLC      Telephone: 802-933-8336  
    Address: 1662 Pumpkin Village Road, Enosburg Falls, VT 05450      Email: agrilabtech1@gmail.com  
         Website: www.agrilabtech.com

U.S. representative (if foreign country):      Name: \_\_\_\_\_      Telephone: \_\_\_\_\_  
    Address: \_\_\_\_\_      Email: \_\_\_\_\_  
         Website: \_\_\_\_\_

Vendor description of company:      Agrilab Technologies, LLC specializes in thermal energy (heat) capture and transfer from the aeration and composting of biodegradable materials such as food waste, by-products of food processing, farm manure and bedding, and other types of biomass. Farm-generated manures can be from horse, cow, small ruminant, or poultry operations. Agrilab Technologies provides technical assistance to create the proper compost blend for efficient operation and optimal thermal energy output. Agrilab Technologies is the only licensed U.S. vendor for Acrolab Ltd. (Windsor, Ontario), which provides ongoing technical support.

Year company established:      2010; initial system at Diamond Hill was through Acrolab Ltd. in 2006.

Other equipment or business: \_\_\_\_\_

## VENDOR SERVICES

			Description	
Site preparation:	Yes	<input checked="" type="checkbox"/>	No <input type="checkbox"/>	Agrilab will coordinate with other contractors and is involved as a project team member, but does not do construction.
System start-up	Yes	<input checked="" type="checkbox"/>	No <input type="checkbox"/>	
Gas processing equipment and Engine-generator set repair:	Yes	<input type="checkbox"/>	No <input type="checkbox"/>	n/a
Technical support:	Yes	<input checked="" type="checkbox"/>	No <input type="checkbox"/>	Agrilab assists in all stages, from conceptual design and pursuing funding through installation and operations.

## OPERATING SYSTEMS

Number of operating systems: 3      Number of systems under construction: 1

### Systems Currently in Operation in the U.S. and Canada:

<u>Name of site</u>	<u>Name of Owner/Operator</u>	<u>Address:</u>
<b>1</b> Diamond Hill Custom Heifers	Terry Magnan	Sheldon, VT
Date system began operating:	2006	
Brief Description (including size of system, waste being processed and processed waste disposal):	Composting area of 60ft by 52ft handles roughly 800 tons of compost. System processes animal manure and bedding and produces heat to warm barns (radiant floor loops) and process water (for sanitation and preparation of calf feed).	
<b>2</b> University of New Hampshire Organic Research Dairy Farm	University of New Hampshire	Lee, NH
Date system began operating:	2013	
Brief Description (including size of system, waste being processed and processed waste disposal):	Composting area of 30 by 100ft handle between 200 and 400 tons of compost. System processes animal manure and bedding and sends heated water to milking parlor.	

## OPERATING SYSTEMS

3 Jasper Hill Farm

Andy and Mateo Kehler

Greensboro, VT

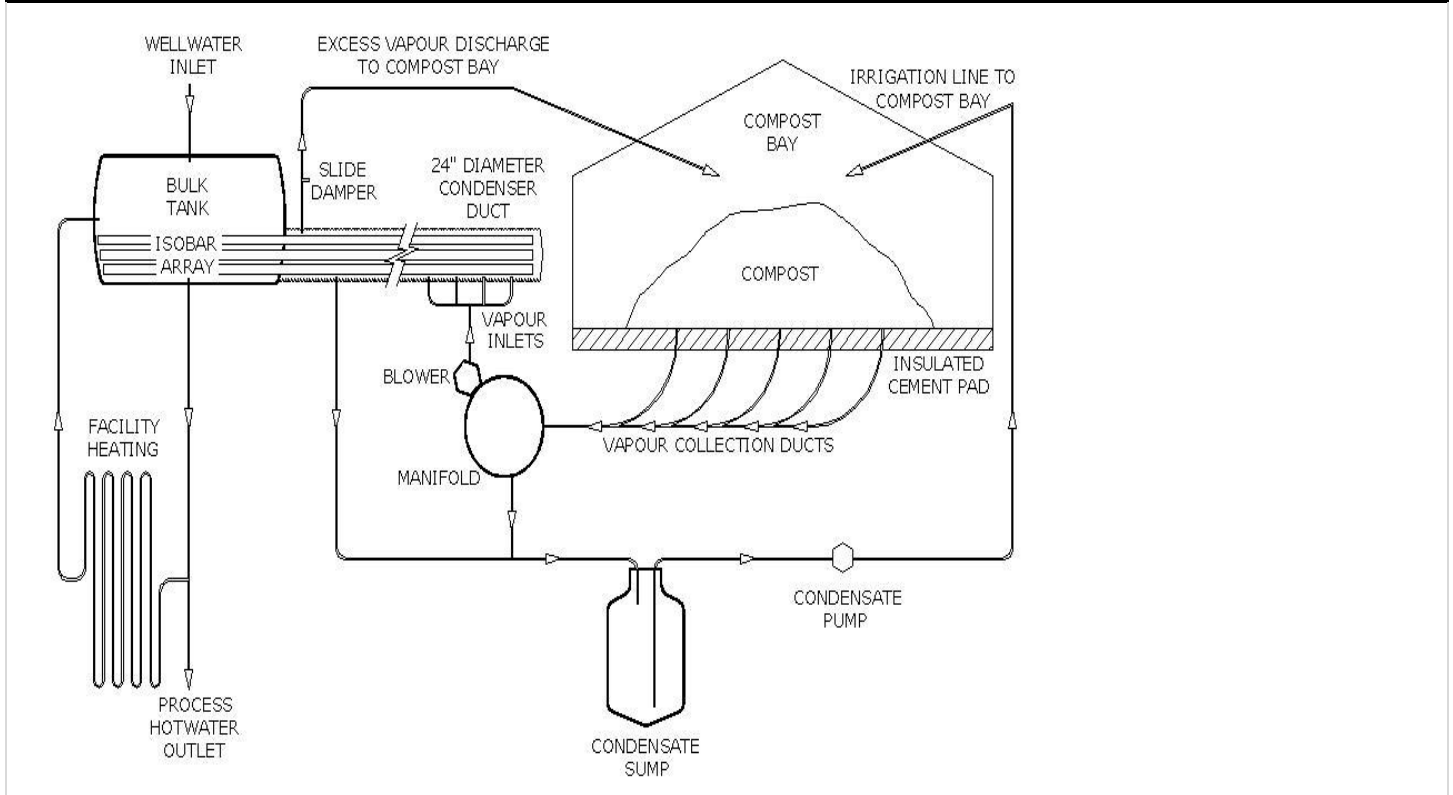
Date system began operating:

2012

Brief Description (including size of system, waste being processed and processed waste disposal):

System uses animal manure, bedding, waste feed, and bark/leaves as feedstock. Heat warms anaerobic and biological treatment systems and a greenhouse. Gas runs through boiler, and site waste liquids are heated and run through a series of wetland and soil treatment cells.

## SCHEMATIC



## Organics-To-Energy Small Technologies Evaluation Form

### GENERAL INFORMATION

Name of technology: Zonally-mixed Plug-flow Digester

Vendor/brand name(s): Avatar Energy

Type of technology:  Composting  Dry AD  Slurry/Wet AD

Process: Plug-flow mesophilic anaerobic digestion

Vendor description of technology: Modular system geared towards small to mid-sized farms of 100 to over 1000 cows with collected manure as a slurry of 8 to 12% solids, ideally where sand is not used as bedding or has been pre-separated. The plug flow system operates in the mesophilic temperature range. The manure is processed in the digester hull for 18 to 21 days. The system has automated operations with remote monitoring and is heavily insulated for operations in cooler climates.

### SUITABLE APPLICATIONS

Capped Landfills  Small Farm  Institutional/Campus

Operating Landfill  Co-Located with Composting Operation  Other:

Urban Settings  Food Manufacturer  Remote locations

### REACTOR DETAILS

Operating volume 1,750-60,000 ft<sup>3</sup>  
Ranging from a 50 ft shipping containerized hull to four parallel 12 ft diameter fiberglass vessels For 30 tons/day, the operating volume would be 20,000 ft<sup>3</sup>.

Processing capacity 86-3,070  ft<sup>3</sup>/day 1000 ft<sup>3</sup>/day for 30 tons/day system.

Retention time 18-21 days

Operating type  Continuous

For composting, recoverable heat at maximum processing capacity \_\_\_\_\_

Footprint: 1,100-9,600 ft<sup>2</sup>; 3,000 ft<sup>2</sup> for a 30 ton/day system.

Physical structure:  Prefabricated (modular)

Describe: Standardized modular fiberglass units combined on-site. Hull sections can be linked, arranged in parallel, and lengthened to adjust the capacity. The digester hulls sit on concrete footers, and can be completely disassembled to be moved.

## HOST FACILITY REQUIREMENTS

Describe structural requirements (e.g., a concrete pad for prefabricated systems): Concrete pads under main reactor tank cradles. An insulated building is required to house pumps, water and gas lines, control equipment only, with the digester vessels are placed outside.

	Yes	No		Describe
Utility connections				
Electrical interconnection to the grid	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Site dependent, varying with access to 3-phase power.
Water supply	<input checked="" type="checkbox"/>	<input type="checkbox"/>	0-100 gal/day	Wash down requirements minimal.
Sewer connection	<input type="checkbox"/>	<input checked="" type="checkbox"/>		Unless processing food waste in an urban setting.
Operational equipment necessary, but not included (e.g. solids separator)	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Optional pre-treatments, generator, solids separator, gas conditioning.
Buildings and structures required for equipment and operations	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Insulated building to house gas and electrical equipment as well as small portion of reactor and manure handling; digester sits outside building.
Other outdoor area required for operations (e.g. containment pond)	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Additional feedstock and effluent storage may be required, depending on existing facility.

## BIOGAS UTILIZATION

Equipment included?	Gas collection plumbing, gas flow meter, pressure sensor, water traps and supply manifolds, flare and control valving. System controls include flow monitoring and automated flare controls. Biogas appliances (genset, boiler) are integrated into the system controls for remote monitoring and operation.		
Interconnect switching included?	No		
Type of biogas processing (e.g. drying, H <sub>2</sub> S scrubbing):	Water traps, iron sponge, biological (expected available in 2014).		
Engine-generator set make/model:	Various makes and models.	Efficiency	28-35 %
Capacity (kW), voltage, and single or three phase:	6Kw-950Kw, 120-600VAC, single and three phase. 70kW from 30 tons/day dairy manure. Co-substrate addition can increase this output significantly.		
Non-electrical use:	Excess hot water can be used for on-site heat and hot water.		

## FEEDSTOCK

Minimum and maximum inputs:	2.6 to 90 depending on model.	<input checked="" type="checkbox"/> tons per day
Acceptable moisture content	88-92% for manure, 75-80% for food waste.	
Pretreatment required?	<input type="checkbox"/> no <input checked="" type="checkbox"/> If yes, Describe: Ideally, sand bedding would be pre-separated. Non-manure organics should be passed through a grinder.	

Acceptable for System	Type of Feedstock	Predicted Volume Reduction, %
<input checked="" type="checkbox"/>	Livestock manure (3 to 10% total solids)	<15% %
<input checked="" type="checkbox"/>	Livestock manure (>10% total solids)	>15 %
<input checked="" type="checkbox"/>	Food wastes	20-30 %
<input checked="" type="checkbox"/>	Organic matter separated from municipal solid wastes	10-15 %
<input checked="" type="checkbox"/>	Non-woody yard wastes	10 %
<input checked="" type="checkbox"/>	Other organic wastes: Fats, oils, greases (FOG)	100 %

## FEEDSTOCK

Comments: Substrates with smaller particle size will be more efficient (i.e., pre-processing through grinder/crusher pumps). Non-woody yard wastes may require longer retention times. FOG is added as a co-substrate to a fibrous feedstock.

## OUTPUT / DIGESTATE

Required holding capacity:

Comment: Solids content varies with feedstock. Digested manure effluent separates into 85% of the original liquid volume with a fibrous solid (1 cubic yard/1000 gal effluent). Digested food waste is separated to produce a liquid that can be returned to sewer with low BOD; separated solids are 30-60% of original volume and can be composted directly.

Type of Digestate	Quantity	Characteristics	Uses/Disposal Options
Liquid		Depends on equipment used for effluent separation.	Liquids - for direct field application of nutrients (manure), or treatment in WWTF (foodwaste).
Solid		Depends on equipment used for effluent separation.	Solids - pathogen-free for animal bedding (manure), or composting (food waste).
Combined Liquid/Solid		Equivalent to input volume.	

## OPERATION AND MAINTENANCE REQUIREMENTS

	Hours per week (if known)			Comment
	Low	Medium	High	
Operator expertise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Remote system monitoring and operation included.
Seasonal issues	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Cleaning takes 1-3 days every 5-10 years, but varies based on type of bedding used. If more than one unit is in use, one can be shut down for cleaning while the others continue to operate.
Labor				
Receiving	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	.5-1.5
Loading	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	.5-1.5
Unloading	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	.25-.75
Storage	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	.5-1.5
Curing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0
Pretreatment	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	.5-1.5
Mixing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	.25-.75
Process monitoring	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	.5-1.5
Engine and generator set maintenance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	.5-1.5
Biogas processing equipment maintenance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	.25-.75
Residue management	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0
Further processing of gas	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	.25-.75
Further processing of digestate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	.5-1.5
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Total Labor Per Week (sum of above):</b>				<b>5-15 hr</b> Labor increases with system capacity.

## POTENTIAL NUISANCE CONCERNS AND MITIGATION MEASURES

	Low	Medium	High	Description of Nuisance	Mitigation Measures
Odors	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Genset enclosed in building or cabinet.
Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

## SYSTEM EXPENSES

Capital costs:	\$250k-4.0 million; (<\$950,000 for 30 ton /day system)	Cost for routine maintenance and supplies:	\$ 1,200-6,000 per year
Brief description of costs above (what size system was assumed, what equipment is included, etc)	Prices are for systems installed, including site engineering, digester vessels, hot water heating system, digester mixing system, feed pump, controls and sensors for local and remote monitoring and operation, and gas collection water traps and supply manifolds and flare.		
Shipping and installation:	Included but varies.	Dealer service call cost: \$ 80/hr	Warranty cost (if available): \$
Warranty availability and features (if available):	1 yr warranty on equipment included in Avatar core package (vessels, heating, gas handling and feed pump/valving and control system).		
Expected life of systems	Fiberglass vessel expected to remain serviceable for >30 years.		
Financing options offered:	<input type="checkbox"/> Lease	<input checked="" type="checkbox"/> Buy	<input checked="" type="checkbox"/> Other: 3 <sup>rd</sup> Party Investment Program in some states with feed in tariffs.

## VENDOR INFORMATION

System manufacturer:	Name: AVATAR	Telephone: (877) 282-8270
	Address: AVATAR Corporate Office - 1981 N. Broadway, Suite 430, Walnut Creek, CA 94596	Email: info@avatarenergy.com
		Website: www.avatarenergy.com
U.S. representative (if foreign country):	Name: _____	Telephone: _____
	Address: South Burlington, VT (Sales and Engineering)	Email: _____
		Website: _____
Vendor description of company:	AVATAR Energy, a renewable energy company founded in 2005, has developed a scalable, modular anaerobic digester using horizontal tubular vessels, geared particularly to small and mid-sized farms of 100 to 2,500 cows. Avatar's zonal mixing system allows the use of a wide range of feedstocks and co-substrates, including food waste, FOGs, and other energy-rich organics.	
Year company established:	2005	
Other equipment or business:	_____	

**VENDOR SERVICES****Description**

Site preparation: Yes  No

Site evaluation.

System start-up: Yes  No

Feedstock formulation, inoculation, and scheduled digester filling to steady state provided with digester.

Gas processing equipment and engine-generator set repair: Yes  No

Technical support: Yes  No

In-house lab testing of feedstock biogas potential and pathogen kill rates available.

**OPERATING SYSTEMS**

Number of operating systems: 2

Number of systems under construction:

Three systems planned in Nevada (for the Frade Ranch and Desert Hills Dairy in Yerington, and Hillside Dairy farm in Fallon).

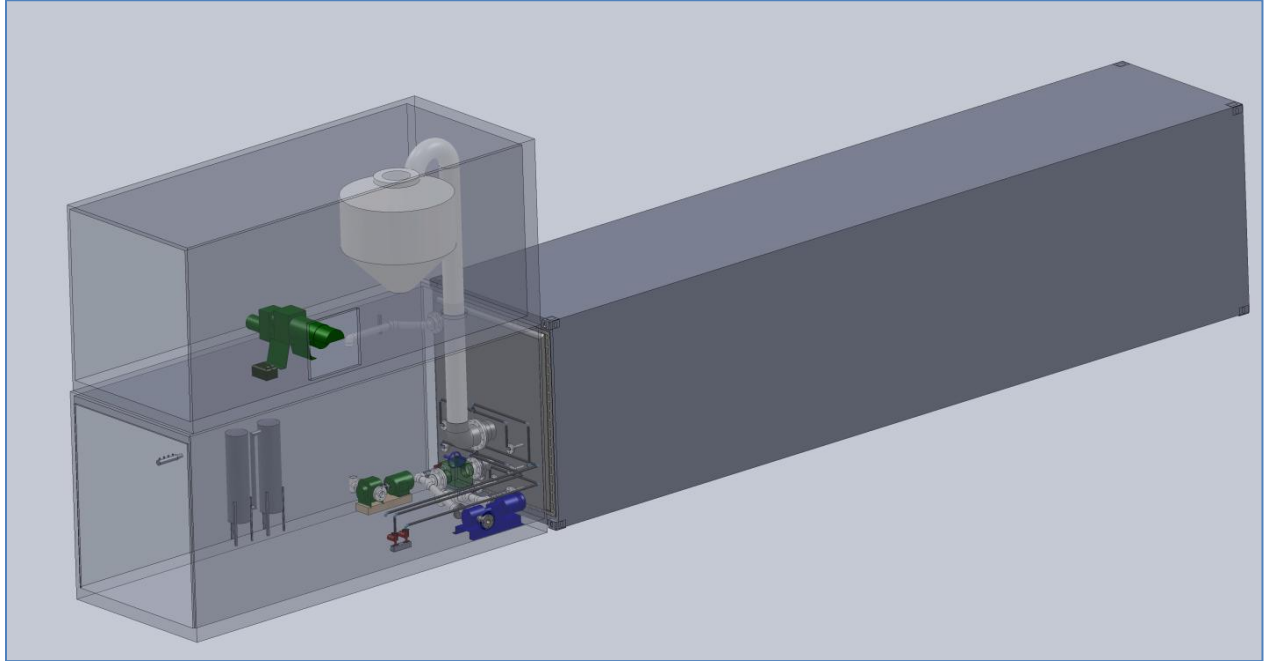
**Systems Currently in Operation in the U.S. and Canada:**

<b>Name of site</b>	<b>Name of Owner/Operator</b>	<b>Address:</b>
<b>1</b> Keewaydin Farm	Leslie and Claire Pike	Waterbury Road, Stowe, VT
Date system began operating:	2011	
Brief description (including size of system, waste being processed and processed waste disposal):	Digester sized for 75 head dairy herd, accepting 1,200 gal/day manure at 9-12% solids. Solids used as animal bedding, liquids stored for field application.	
<b>2</b> Bakerview Eco Dairy	Bill Vanderkooi	Abbotsford, BC, Canada
Date system began operating:		
Brief description (including size of system, waste being processed and processed waste disposal):	Digester sized for 75 head dairy herd. Whey used as co-substrate to double biogas production. Solids sold off site and liquids are land applied.	



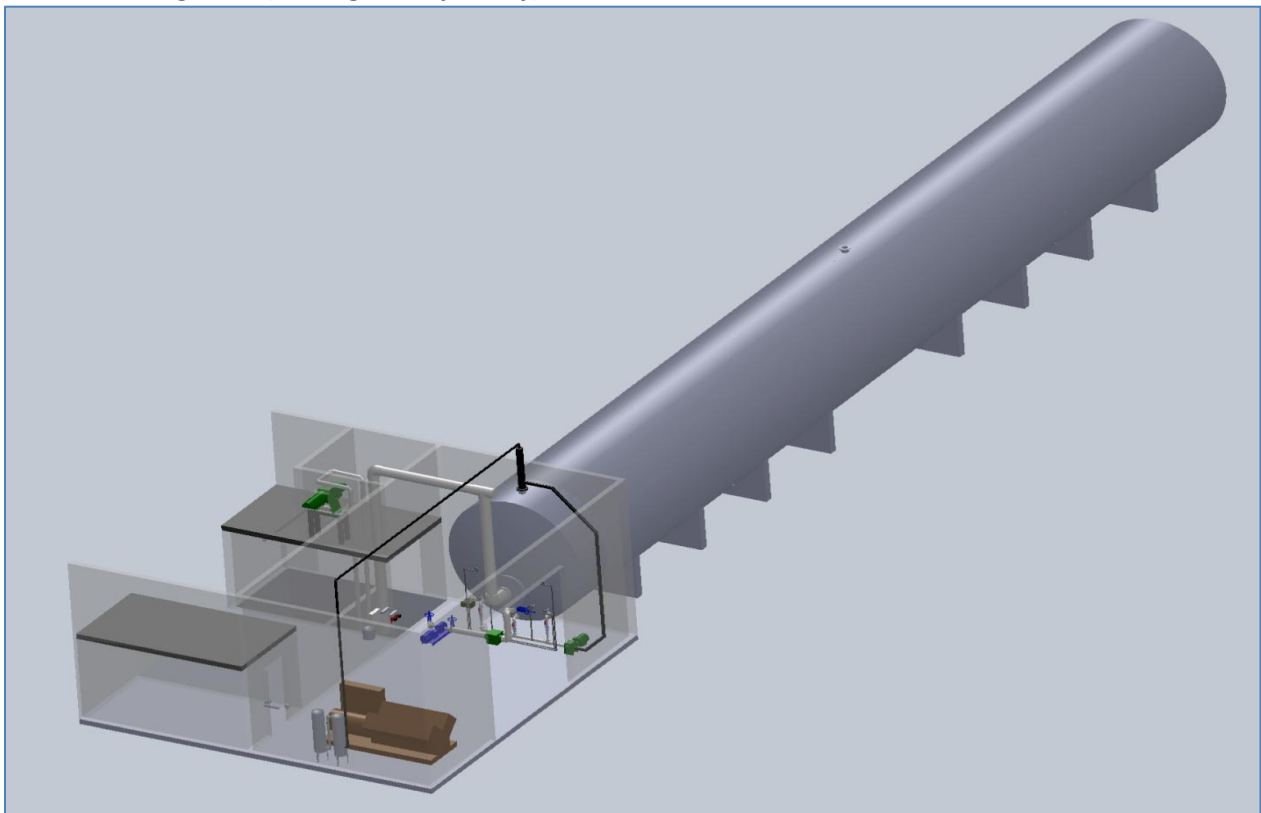
**SCHEMATIC**

**Avatar 'MPF Compact' Digester (less than 1,500 gallons per day)**



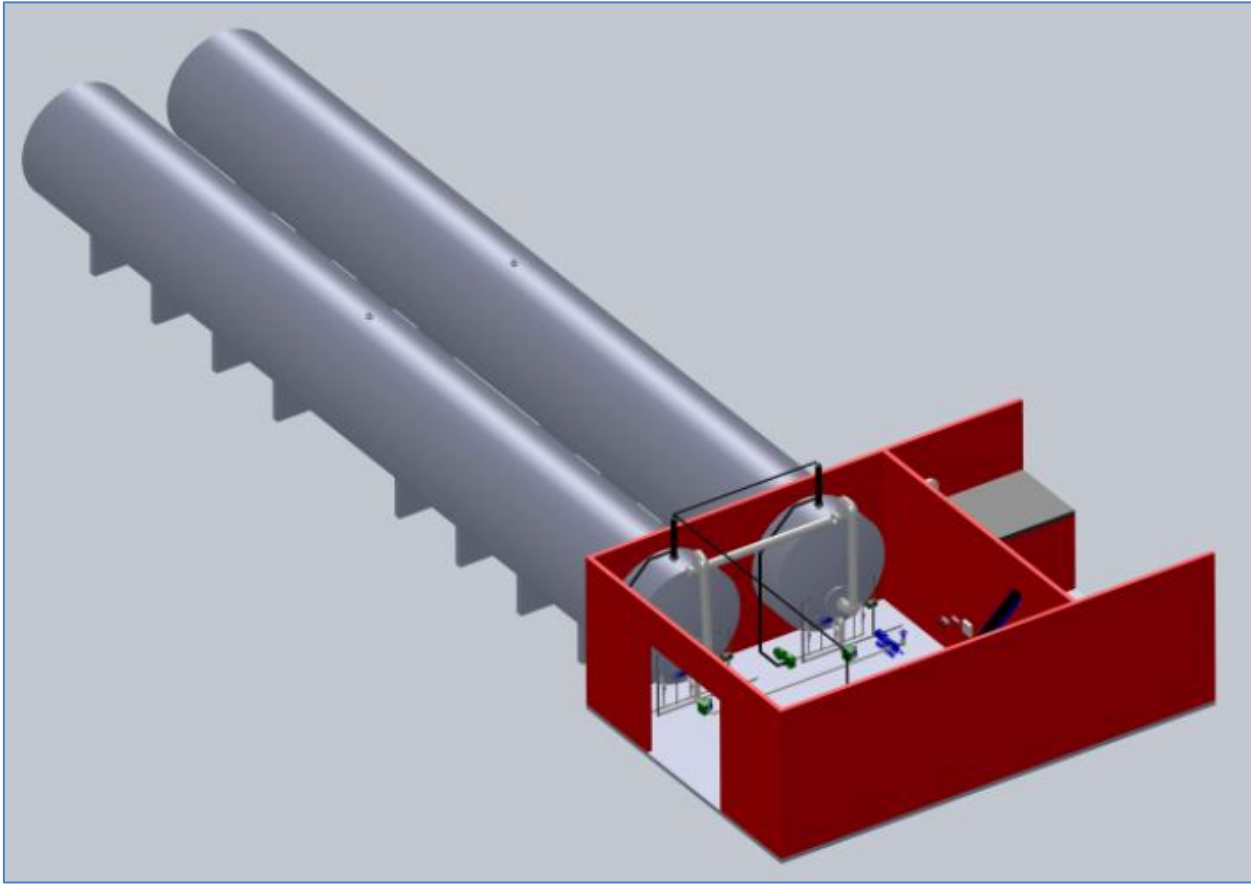
Patents pending, Avatar Energy, LLC

**Avatar 'MPF' Series Digester (1,900 gallons per day)**



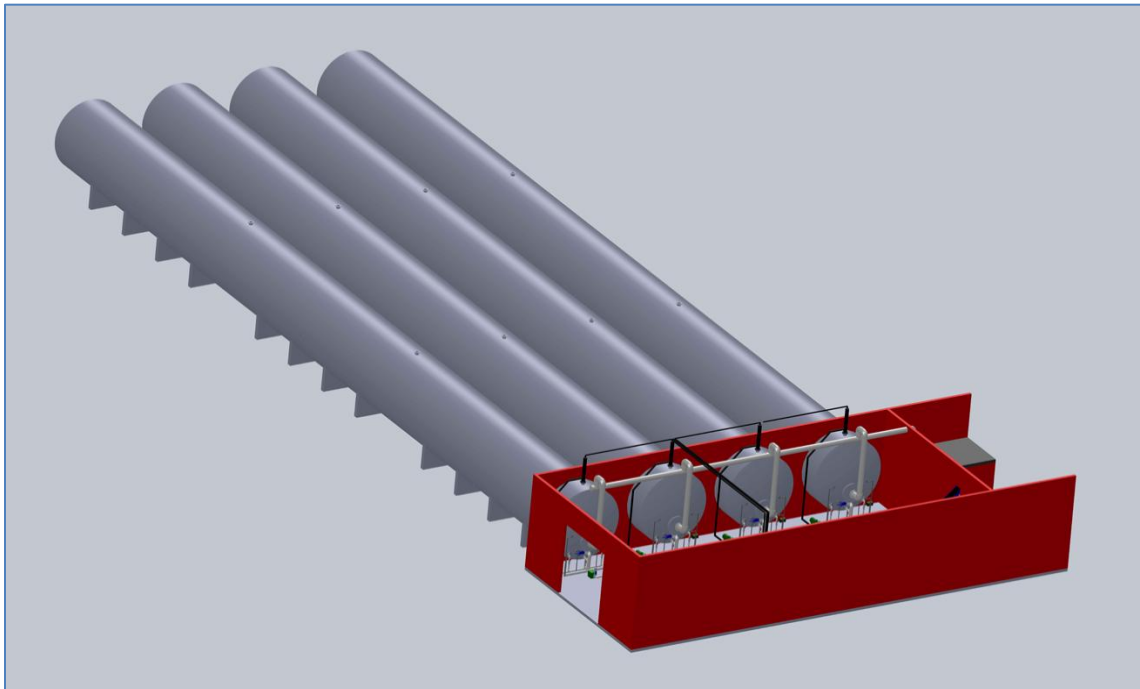
Patents pending, Avatar Energy, LLC

**Avatar 'MPF' Series Digester – Twin hull configuration – “2B12” (7,500 gallons per day)**



Patents pending, Avatar Energy, LLC

**Avatar 'MPF' Series Digester – Four hull configuration – “4B12” (22,500 gallons per day)**



Patents pending, Avatar Energy, LLC

## Organics-To-Energy Small Technologies Evaluation Form

### GENERAL INFORMATION

Name of Technology: COCCUS

Vendor/Brand Name(s): BIOFerm Energy System

Type of Technology:  Composting  Dry AD  Slurry/Wet AD

Process: Complete mix anaerobic digestion

Vendor description of technology: COCCUS® is a complete mix anaerobic digester designed to run at the mesophilic temperature range. It is designed for input materials with low solids content (between 8-12%). The tank is a reinforced concrete design with 2 or 3 large REMEX® paddle mixers. The drive motor of the mixer is mounted onto the outside wall of COCCUS® so that only the polyamide bearings are located inside the fermenter. The tank is heated through hydronic heating installed onto the interior tank wall. Biological desulfurization is integrated into the wooden roof structure of the gas storage, which provides for removal of a large part of the hydrogen sulfide.

### SUITABLE APPLICATIONS

Capped Landfills  Small Farm  Institutional/Campus

Operating Landfill  Co-Located with Composting Operation  Other:

Urban Settings  Food Manufacturer

### REACTOR DETAILS

Operating volume: 24,000 ft<sup>3</sup>

Processing capacity: 30 tons/day

Retention time: 20-40 days

Operating type:  Continuous

Footprint: 2,000 ft<sup>2</sup>

Physical structure:  Constructed onsite

Describe:

### HOST FACILITY REQUIREMENTS

Describe structural requirements (e.g., a concrete pad for prefabricated systems):

	Yes	No	Describe
Utility connections			
Electrical interconnection to the grid	<input checked="" type="checkbox"/>	<input type="checkbox"/>	480V, 3 Phase, 200A
Water supply	<input type="checkbox"/>	<input type="checkbox"/>	
Sewer connection	<input type="checkbox"/>	<input type="checkbox"/>	

Operational equipment necessary, but not included (e.g. solids separator)

All these pieces are optional: PASCO augured feeding system, digestate holding tank, solids separate.

Buildings and structures required for equipment and operations

Other outdoor area required for operations (e.g. containment pond)

Optional – dependent on substrate and final storage.

## BIOGAS UTILIZATION

Equipment included? Options: (CHP unit, boiler, biogas upgrading facility).

Interconnect switching included? Dependent on utility and options selected by client.

Type of biogas processing (e.g. drying, H<sub>2</sub>S scrubbing): Typically moisture removal and activated carbon filter.

Engine-generator set make/model: Dependent on feedstock and biogas use. Efficiency 35-45 %

Capacity (kW), voltage, and single or three phase: 55-100kW capacity, three phase.

Non-electrical use: Heat utilization.

## FEEDSTOCK

Minimum and maximum inputs: 15 - 30  tons per day  tons per year

Acceptable moisture content Digester input ~86% moisture

Pretreatment required?  no  If yes, Describe: Note: certain feedstocks procured by client may need pretreatment.

### Acceptable

for System	Type of Feedstock	Predicted Volume Reduction, %
<input checked="" type="checkbox"/>	Livestock manure (3 to 10% total solids)	3-5 %
<input checked="" type="checkbox"/>	Livestock manure (>10% total solids)	5-20 %
<input checked="" type="checkbox"/>	Food wastes	20-40 %
<input checked="" type="checkbox"/>	Organic matter separated from municipal solid wastes	20-40 %
<input checked="" type="checkbox"/>	Non-woody yard wastes	20-40 %
<input checked="" type="checkbox"/>	Other organic wastes:	Varies %

Comments: \_\_\_\_\_

## OUTPUT / DIGESTATE

Required holding capacity:  $\text{ft}^3$  Comment: 700 -1,000 ft<sup>3</sup>/day

Type of Digestate	Quantity	Characteristics	Uses/Disposal Options
Liquid	~8,760 tons per year or ~32,000,000 ft <sup>3</sup> /yr	Varies by separation technology.	In agricultural application it can be land applied as fertilizer.
Solid		Varies by separation technology.	Process further to a salable compost product.
Combined Liquid/Solid		Note: these values have been provided based on input of food waste feedstock at approximately 16%TS.	

## OPERATION AND MAINTENANCE REQUIREMENTS

	Low	Medium	High	Hours per week (if known)	Comment
Operator expertise	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Seasonal issues	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Labor					
Receiving	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Loading	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Unloading	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		*Note: The type of feedstock used and its potential pre-processing may impact labor requirements.
Storage	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Curing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Pretreatment	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Mixing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Process monitoring	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Engine and generator set maintenance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Biogas processing equipment maintenance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Residue management	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Further processing of gas	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Further processing of digestate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
<b>Total Labor Per Week (sum of above):</b>				<b>7-10 hr</b>	

## POTENTIAL NUISANCE CONCERNS AND MITIGATION MEASURES

	Low	Medium	High	Description of Nuisance	Mitigation Measures
Odors	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

## SYSTEM EXPENSES

Capital costs:	<u>\$ 750,000</u>	Cost for routine maintenance and supplies:	<u>\$10,000 to 18,000 per year (depending on feedstock).</u>
Brief description of costs above (what size system was assumed, what equipment is included, etc)	<u>COCCUS 800, controls, process pump/equipment, foundation, instrumentation, engineering, construction.</u>		
Shipping and installation:	\$ Included in capital costs	Dealer service call cost:	\$600/day (expenses not included). Warranty cost (if available): \$ 0, warranted for 18 months.
Warranty availability and features (if available):	<u>Additional warranty coverage available on all components supplied.</u>		
Expected life of systems	<u>20 years</u>		
Financing options offered:	<input type="checkbox"/> Lease <input checked="" type="checkbox"/> Buy <input type="checkbox"/> Other: _____		

## VENDOR INFORMATION

System manufacturer:	<u>BIOFerm™ Energy Systems</u>	Telephone:	<u>608-467-5523</u>
Address:	<u>617 N. Segoe Rd. Madison, WI 53705</u>	Email:	_____
		Website:	<u>www.biofermenergy.com</u>
U.S. representative (if foreign country):	<u>Amber Blythe</u>	Telephone:	<u>608-467-5523</u>
Address:	_____	Email:	<u>blya@biofermenergy.com</u>
		Website:	_____
Vendor description of company:	<u>With organic waste and manure as the primary input, BIOFerm™ technology produces high-quality biogas through specialized industrial-scale processes that provide carbon neutral energy production, system reliability, waste volume reduction, system simplicity, fully automated management control systems, and energy expenditure savings. BIOFerm™ systems are used for heat and electric energy production solutions and waste management plans that integrate with industrial, corporate, agricultural, landfill, composting, institutional, and real estate operations.</u>		
Year company established:	<u>2007</u>		
Other equipment or business:	<u>Complete mixed stirred tank digester, dry fermentation digester, hybrid systems, and small containerized digester.</u>		

## VENDOR SERVICES

	Yes	No	Description
Site preparation:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____
System start-up	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____
Gas processing equipment and engine-generator set repair:	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<u>Repair and maintenance performed by CHP installer.</u>
Technical support:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____

## OPERATING SYSTEMS

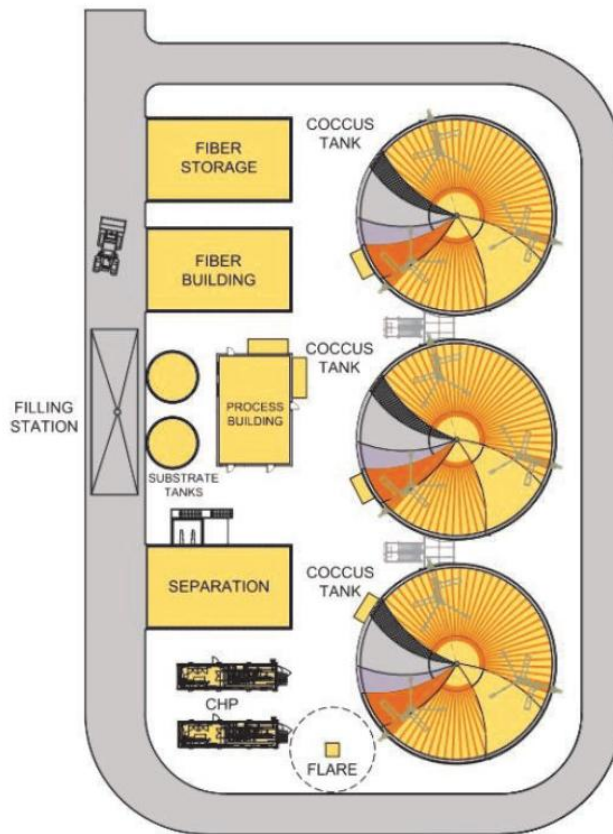
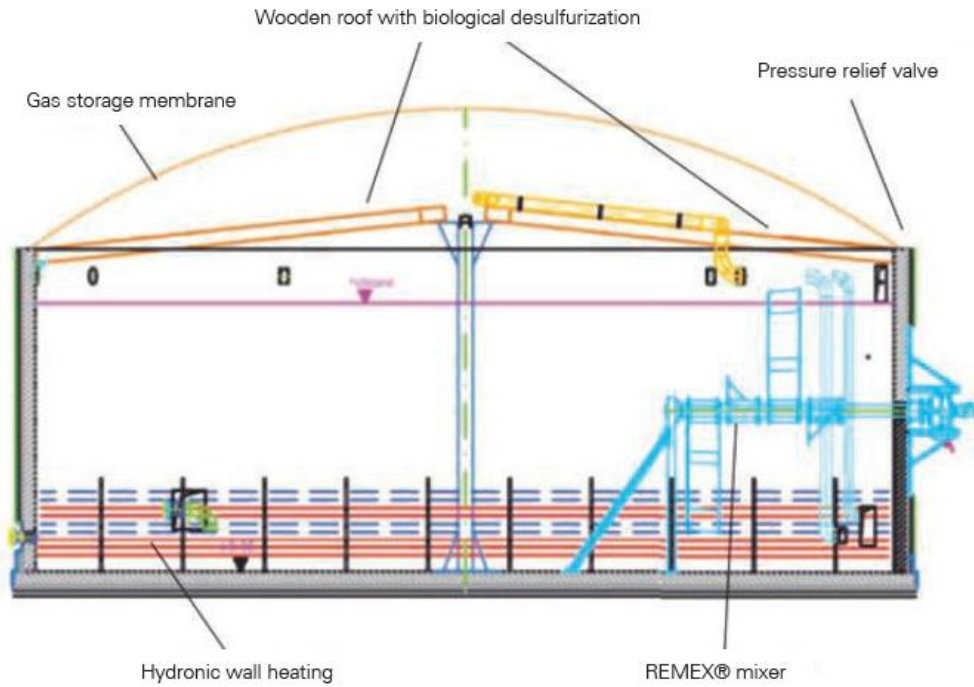
Number of operating systems: 250+ in Germany,  
1 in US (below) Number of systems under construction: 1 planned in US (in  
Wisconsin)

### Systems Currently in Operation in the U.S. and Canada:

<b>Name of site</b>	<b>Name of Owner/Operator</b>	<b>Address:</b>
KB Composting	Annette M. Berger	2677 Riverview Road Akron, OH 44313-4719
Date system began operating:	2007	
Brief description (including size of system, waste being processed and processed waste disposal):	<p>The anaerobic digester at the City of Akron, Ohio, was constructed to treat the sewage sludge from the municipal wastewater treatment plant. The system was built as a joint venture between the city and KB Compost Services, which had already been operating the city's composting facility to compost biosolids from the wastewater treatment plant.</p> <p>The system includes:</p> <ul style="list-style-type: none"><li>1 horizontal plug flow digester EUACO® with a capacity of 160,000 gallons.</li><li>1 complete mix COCCUS® digester with a capacity of 500,000 gallons.</li><li>1 All-in-One (AIO) technical container with a Jenbacher Type 2 J208 GS CHP unit, and all other technical equipment.</li></ul> <p>In 2012, KB Compost Services started the expansion of the plant to increase the total capacity to 13,000 dry tons. The expansion will add two EUACO® and two COCCUS® tanks and increase the power capacity of 1.2 MW. As a representative of the Schmack technology for the US market, BIOFerm™ Energy Systems will provide the technical design and equipment. The plant is scheduled to start operation in 2013.</p>	

# SCHEMATIC

## BIOferm COCCUS Schematics



Source: <http://www.biofermenergy.com/wp-content/uploads/2011/11/COCCUS-Plant-Systems.pdf>



## Organics-To-Energy Small Technologies Evaluation Form

### GENERAL INFORMATION

Name of technology: EUCOIno

Vendor/brand name(s): BIOFerm™ Energy System

Type of technology:       Composting       Dry AD       Slurry/Wet AD

Process: Plug-flow mesophilic anaerobic digestion

Vendor description of technology: EUCOIno is a compact containerized biogas plant system that uses biomass to create energy through anaerobic digestion, and is designed for small-scale applications. The system is designed for agricultural operations with a limited amount of biomass, and can utilize a number of different feedstock options, including manure, yard waste, and food waste. The system is simple, flexible and can be easily integrated into established operations. It is characterized by small space requirements due to its modular structure. The different plant components are pre-manufactured units that are shipped as complete systems from the supplier to minimize additional assembly work and time on-site.

### SUITABLE APPLICATIONS

- Capped Landfills       Small Farm       Institutional/Campus  
 Operating Landfill       Co-Located with Composting Operation       Other:  
 Urban Settings       Food Manufacturer

### REACTOR DETAILS

Operating volume: 6,500-13,000 ft<sup>3</sup>

Processing capacity: 7.5 - 15 tons/day

Retention time: 22-30 days

Operating type:  Continuous

Footprint: 650- 1,300 ft<sup>2</sup>

Physical structure:  Prefabricated (modular)

Describe: The fermenter units are pre-fabricated containerized digesters that are shipped to the site, where they are placed on a concrete pad foundation along with the feed hopper. The unit is a complete system and includes all interior piping, insulation, and process equipment. The digester is a continuous plug flow system that is fed on one side and emptied on the other. The biogas that is produced during the fermentation process is collected in a storage bag in an enclosed container on top of the unit, from where it is piped to the CHP container for further processing. The digested effluent is periodically pumped and stored.

## HOST FACILITY REQUIREMENTS

Describe structural requirements (e.g., a concrete pad for prefabricated systems):

EUCOLino requires a concrete pad for stabilization/foundation.

	Yes	No	Describe
Utility connections			
Electrical interconnection to the grid	<input checked="" type="checkbox"/>	<input type="checkbox"/>	480V, 3 phase, 200A
Water supply	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Dependent on feedstock. O&M requirements are approximately 5-10 gal/day.
Sewer connection	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Dependent on site location and effluent discharge point.
Operational equipment necessary, but not included (e.g. solids separator)	<input type="checkbox"/>	<input type="checkbox"/>	All these pieces are optional: PASCO augured feeding system, digestate holding tank, solids separate.
Buildings and structures required for equipment and operations	<input type="checkbox"/>	<input type="checkbox"/>	Concrete pad is required for stabilizing EUCOLino. Additional options include building to enclose augured feeding system and biofilter for odor control.
Other outdoor area required for operations (e.g. containment pond)	<input type="checkbox"/>	<input type="checkbox"/>	Optional. Dependent on substrate and final storage.

## BIOGAS UTILIZATION

Equipment included?	<u>Options: CHP unit, boiler, biogas upgrading facility.</u>
Interconnect switching included?	<u>Dependent on utility and options selected by client.</u>
Type of biogas processing (e.g. drying, H <sub>2</sub> S scrubbing):	<u>Typically moisture removal and activated carbon filter.</u>
Engine-generator set make/model:	<u>Dependent on feedstock and biogas use.</u> Efficiency <u>35-45</u> %
Capacity (kW), voltage, and single or three phase:	<u>35-100kW capacity, three phase.</u>
Non-electrical use:	<u>Heat utilization.</u>

## FEEDSTOCK

Minimum and maximum inputs:	<u>7.5-15</u> <input checked="" type="checkbox"/> tons per day <input type="checkbox"/> tons per year
Acceptable moisture content	<u>70-90</u> %
Pretreatment required?	<input checked="" type="checkbox"/> no <input type="checkbox"/> If yes, Describe: <u>Certain feedstocks procured by client may need pretreatment.</u>

### Acceptable

for System	Type of Feedstock	Predicted Volume Reduction, %
<input checked="" type="checkbox"/>	Livestock manure (3 to 10% total solids)	3-5 %
<input checked="" type="checkbox"/>	Livestock manure (>10% total solids)	5-20 %
<input checked="" type="checkbox"/>	Food wastes	20-40 %
<input checked="" type="checkbox"/>	Organic matter separated from municipal solid wastes	20-40 %
<input checked="" type="checkbox"/>	Non-woody yard wastes	20-40 %
<input checked="" type="checkbox"/>	Other organic wastes:	Varies %

Comments: \_\_\_\_\_

## OUTPUT / DIGESTATE

Required holding capacity:

Comment: ~200 – 650 ft<sup>3</sup>/day

Type of Digestate	Quantity	Characteristics	Uses/Disposal Options
Liquid	2,000 to 7,400 tons per year or 73,000 to 237,250 ft <sup>3</sup> per year	Varies by separation technology.	In agricultural application, can be land applied as fertilizer.
Solid		Varies by separation technology.	Process further to a salable compost product.
Combined Liquid/Solid		These values have been provided based on input of food waste feedstock at approximately 10%TS.	

## OPERATION AND MAINTENANCE REQUIREMENTS

	Low	Medium	High	Hours per week (if known)	Comment
Operator expertise	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Seasonal issues	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Labor					
Receiving	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Loading	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Unloading	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		The type of feedstock used and its potential pre-processing may impact labor requirements.
Storage	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Curing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Pretreatment	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Mixing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Process monitoring	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Engine and generator set maintenance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Biogas processing equipment maintenance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Residue management	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Further processing of gas	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Further processing of digestate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
<b>Total Labor Per Week (sum of above):</b>				5-7 hrs	

## POTENTIAL NUISANCE CONCERNS AND MITIGATION MEASURES

	Low	Medium	High	Description of Nuisance	Mitigation Measures
Odors	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

## SYSTEM EXPENSES

Capital costs:	<u>\$ 330,000</u>	Cost for routine maintenance and supplies:	<u>\$ 3,500 per year</u>
Brief description of costs above (what size system was assumed, what equipment is included, etc.)	<u>EUCO 200 (200m<sup>3</sup> system), controls, process pump/equipment, foundation, instrumentation, engineering, construction. Estimated costs do not include CHP, gas use, or gas cleaning in any of the figures.</u>		
Shipping and installation:	<u>Approximately \$150,000 one time charge</u>	Dealer service call cost:	<u>\$600/day Expenses not included</u>
Warranty availability and features (if available):	<u>Additional warranty coverage available on all components supplied.</u>		
Expected life of systems	<u>15+ years</u>		
Financing options offered:	<input type="checkbox"/> Lease <input checked="" type="checkbox"/> Buy <input type="checkbox"/> Other: _____		

## VENDOR INFORMATION

System manufacturer:	Name: <u>BIOFerm™ Energy Systems</u>	Telephone: <u>608-467-5523</u>
	Address: <u>617 N. Segoe Rd. Madison, WI 53705</u>	Email: _____
		Website: <u>www.biofermenergy.com</u>
U.S. representative (if foreign country):	Name: <u>Amber Blythe</u>	Telephone: <u>608-467-5523</u>
	Address: _____	Email: <u>blya@biofermenergy.com</u>
		Website: _____
Vendor description of company:	<u>With organic waste and manure as the primary input, BIOFerm™ delivers technology that produces high-quality biogas through specialized industrial-scale processes that provide carbon neutral energy production, system reliability, waste volume reduction, system simplicity, fully automated management control systems, and energy expenditure savings. BIOFerm™ systems provide heat and electric energy production solutions and waste management plans that integrate with industrial, corporate, agricultural, landfill, composting, institutional, and real estate operations.</u>	
Year company established:	<u>2007</u>	
Other equipment or business:	<u>Complete mixed stirred tank digester and dry fermentation digester.</u>	
Apparent reliability:	<u>92%+</u>	

## VENDOR SERVICES

	Yes	No	Description
Site preparation:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____
System start-up	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____
Gas processing equipment and engine-generator set repair:	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<u>Repair and maintenance performed by CHP installer.</u>
Technical support:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____

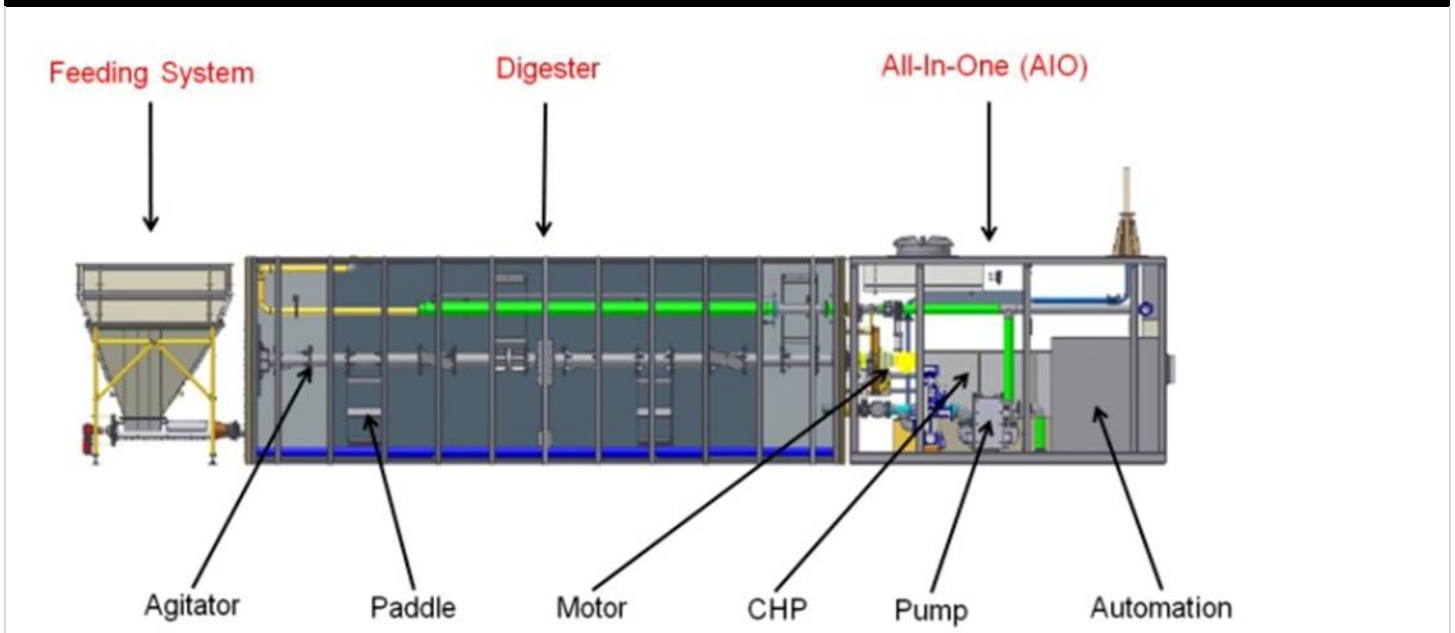
## OPERATING SYSTEMS

Number of operating systems: 6 Number of systems under construction: 2

### Systems Currently in Operation in the U.S. and Canada:

Name of site	Name of Owner/Operator	Address:
	University of Wisconsin - Oshkosh	Oshkosh, WI
Date system began operating:	Spring 2013	
Brief description (including size of system, waste being processed and processed waste disposal):	64kW Unit with 300m <sup>3</sup> fermenter volume. Feedstocks include dairy manure and bedding material.	

## SCHEMATIC



## Organics-To-Energy Small Technologies Evaluation Form

### GENERAL INFORMATION

Name of technology: Mixed-Substrate Anaerobic Digestion Facilities

Vendor/brand name(s): CH Four Biogas

Type of technology:  Composting  Dry AD  Slurry/Wet AD

Process: Mixed mesophilic anaerobic digestion

Vendor description of technology: CH Four Biogas designs and constructs complete-mix mesophilic anaerobic digester facilities for co-digestion of a wide range of organic waste materials. The process results in potential revenue streams from usable energy and an effluent that can be separated for bedding or land-applied as an organic fertilizer.

### SUITABLE APPLICATIONS

Capped Landfills  Small Farm  Institutional/Campus

Operating Landfill  Co-Located with Composting Operation  Other:

Urban Settings  Food Manufacturer

### REACTOR DETAILS

Operating volume: Sizes vary depending on types and quantities of feedstock materials ft<sup>3</sup>

Processing capacity: 10- 150  tons/day

Retention time: 20 - 50 days

Operating type:  Continuous

Footprint: 5,000 - 10,000 ft<sup>2</sup>

Physical structure:  Constructed onsite

Describe: Cast in place concrete reactor vessels.

## HOST FACILITY REQUIREMENTS

Describe structural requirements (e.g., a concrete pad for prefabricated systems):

	Yes	No	Describe
Utility connections			
Electrical interconnection to the grid	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Water supply	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Sewer connection	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Operational equipment necessary, but not included (e.g. solids separator)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Not necessary, but possible.
Buildings and structures required for equipment and operations	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Containers may be used.
Other outdoor area required for operations (e.g. containment pond)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Depending on substrates, maneuvering area for delivery trucks.

## BIOGAS UTILIZATION

Equipment included?	Yes
Interconnect switching included?	Yes
Type of biogas processing (e.g. drying, H <sub>2</sub> S scrubbing):	H <sub>2</sub> S removal included, dewatering included.
Engine-generator set make/model:	Depending on job. Efficiency <u>40</u> %
Capacity (kW), voltage, and single or three phase:	<u>100kW to 1,000kW</u>
Non-electrical use:	Thermal energy use for process and distribution.

## FEEDSTOCK

Minimum and maximum inputs:	<u>10 - 150</u> <input checked="" type="checkbox"/> tons per day <input type="checkbox"/> tons per year
Acceptable moisture content	<u>99 - 70</u> %
Pretreatment required?	<input checked="" type="checkbox"/> no <input checked="" type="checkbox"/> If yes, Describe: Separation of non-organics can be part of system as required.

Acceptable for System	Type of Feedstock	Predicted Volume Reduction, %
<input checked="" type="checkbox"/>	Livestock manure (3 to 10% total solids)	%
<input checked="" type="checkbox"/>	Livestock manure (>10% total solids)	%
<input checked="" type="checkbox"/>	Food wastes	%
<input type="checkbox"/>	Organic matter separated from municipal solid wastes	%
<input type="checkbox"/>	Non-woody yard wastes	%
<input type="checkbox"/>	Other organic wastes:	%

Comments: Livestock manure, food processing wastes, septage

## OUTPUT / DIGESTATE

Required holding capacity: \_\_\_\_\_ Comment: Subject to local requirements.

Type of Digestate

Quantity

Characteristics

Uses/Disposal Options

Liquid			Land application
Solid			Cow bedding
Combined Liquid/Solid			Land application

## OPERATION AND MAINTENANCE REQUIREMENTS

Not enough information provided by the vendor to complete this section.

## POTENTIAL NUISANCE CONCERNS AND MITIGATION MEASURES

	Low	Medium	High	Description of Nuisance	Mitigation Measures
Odors	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

## SYSTEM EXPENSES

Capital costs: \$ 2,000,000 Cost for routine maintenance and supplies: \$ 225,000 per year

System costs per kW of installed genset capacity can range widely, depending on:

- process volume and size of system
- type of feedstocks and feedstock handling (pasteurization, mechanical separation, etc.)
- site requirements and emission controls
- design options and level of system automation
- build option (design/supply, design/build, turnkey, etc.)

Brief description of costs above (what size system was assumed, what equipment is included, etc)

Capital costs above are for a 1,000m<sup>3</sup> system with reception, digestion, separation, engine, gas storage, monitoring, automation, flare, etc. Annual costs include digester and engine maintenance, labor, electrical consumption, equipment replacement, reinvestment, and general operation.

Shipping and installation: \$ 50,000 Dealer service call cost: \$ Warranty cost (if available): \$

Warranty availability and features (if available):

Expected life of systems 30+ years

Financing options offered:  Lease  Buy  Other:

## VENDOR INFORMATION

System manufacturer: CH Four Biogas Telephone: 866 730 6500

Address: 102-1390 Prince of Wales Dr., Ottawa, ON K2C 3N6 Canada Email:

Website: www.chfour.ca

U.S. representative (if foreign country): Sylke Chesterfield Telephone: 518 632 4530

Address: 32 Clearview Terrace Email: SChesterfield@CHFourBiogas.com

Website: www.CHFourBiogas.com

Vendor description of company:



## VENDOR INFORMATION

Year company established: 2006

Other equipment or business: \_\_\_\_\_

## VENDOR SERVICES

Site preparation:	Yes			Description
System start-up	Yes <input checked="" type="checkbox"/>	No	<input type="checkbox"/>	_____
Gas processing equipment and engine-generator set repair:	Yes <input type="checkbox"/>	No	<input type="checkbox"/>	<u>Separate contract with genset vendor.</u>
Technical support:	Yes <input checked="" type="checkbox"/>	No	<input type="checkbox"/>	_____

## OPERATING SYSTEMS

Number of operating systems: 14 Number of systems under construction: 3

Systems Currently in Operation in the U.S. and Canada: Full list available at <http://www.chfour.ca>

Name of site	Name of Owner/Operator	Address:
<b>1</b> Geranik Farms and Biogas Cogeneration		St. Albert Ontario, Canada
Date system began operating:	2009	
Brief description (including size of system, waste being processed and processed waste disposal):	Farm with 75 lactating cows accepting off-farm feedstocks. Digester is 1,000m <sup>3</sup> .	
<b>2</b> Township of Georgian Bluffs/ Township of Chatsworth		Owen Sound Ontario, Canada
Date system began operating:	2011	
Brief description (including size of system, waste being processed and processed waste disposal):	Facility accepts process dewatered septage as well as solid feedstock. Digester is 1,000m <sup>3</sup> .	
<b>3</b> Pinehedge Farms		St. Eugene Ontario, Canada
Date system began operating:	2007	
Brief description (including size of system, waste being processed and processed waste disposal):	Dairy farm and dairy product producer with 500m <sup>3</sup> digester.	

## SCHEMATIC

Schematic not available.

## Organics-To-Energy Small Technologies Evaluation Form

### GENERAL INFORMATION

Name of technology: DRANCO & DRANCO-FARM

Vendor/brand name(s): Organic Waste Systems (OWS)

Type of technology:  Composting  Dry AD  Slurry/Wet AD

Process: Vertical plug-flow, thermophilic with partial recycle

Vendor description of technology: The vertical plug flow anaerobic digester can accept agricultural waste, industrial by-products, and other organic waste. The DRANCO process consists of a thermophilic, single-phase anaerobic digestion step, which is followed by a short aerobic maturation phase. Mesophilic operation can also be applied for specific waste streams. During the anaerobic digestion phase, the organic material is partially converted into biogas. The process takes place in an enclosed digester for 15 to 30 days. The digested residue is extracted from the digester and stabilized aerobically. The final product is a hygienically safe and stabilized product. Partial stream digestion of the waste, whereby the digestate is mixed with a part of the organic fresh waste in order to be treated in a subsequent aerobic composting system, is made possible due to the high total solids content of the digestate. This symbiosis between anaerobic digestion and aerobic composting produces energy, shortens the aerobic composting step, and prevents wastewater production. The DRANCO process generates 220 to 440kW hours per ton of waste.

### SUITABLE APPLICATIONS

Capped Landfills  Small Farm  Institutional/Campus

Operating Landfill  Co-Located with Composting Operation  Other:

Urban Settings  Food Manufacturer Co-located with MRF.

### REACTOR DETAILS

Operating volume: Up to 147,800ft<sup>3</sup> per reactor vessel.

Processing capacity: For the organic fraction of municipal solid waste, up to 180 tons/day per reactor vessel; for source separated organic waste, up to 150 tons/day.

Retention time: 15-30 days

Operating type:  Continuous

Footprint: 3600ft<sup>2</sup> per largest reactor vessel.

Physical structure:  Prefabricated (modular) or  Constructed onsite

Describe: Small 3,333 ton/yr digester vessels are prefabricated and can be installed in sets of 2-3. All other sizes constructed on-site.

### HOST FACILITY REQUIREMENTS

Describe structural requirements (e.g., a concrete pad for prefabricated systems): Concrete foundation.

## HOST FACILITY REQUIREMENTS

	Yes	No	Describe
Utility Connections			
Electrical interconnection to the grid	<input checked="" type="checkbox"/>	<input type="checkbox"/>	480/12/3 amperage/voltage/phase Specifications vary by utility and genset.
Water supply	<input checked="" type="checkbox"/>	<input type="checkbox"/>	725 gal/day For steam production and small cleaning.
Sewer connection	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Operational equipment necessary, but not included (e.g. solids separator)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Post-digestion solids separation can be included or excluded from the scope.
Buildings and structures required for equipment and operations	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Civil construction is site-specific and excluded from the scope.
Other outdoor area required for operations (e.g. containment pond)	<input type="checkbox"/>	<input type="checkbox"/>	Depends on whether digestate is dewatered, and if separated liquid is stored on-site.

## BIOGAS UTILIZATION

Equipment included?	Biogas condensate removal, biogas storage always included. Optional for OWS to provide all other biogas conditioning and utilization equipment.		
Interconnect switching included?	No		
Type of biogas processing (e.g. drying, H <sub>2</sub> S scrubbing):	As requested by client.		
Engine-generator set make/model:	As requested by client, or OWS can select from 5 options.	Efficiency	Depends on size, 35-42%
Capacity (kW), voltage, and single or three phase:	From 150kW to 2 MW, 480V, 3 phase.		
Non-electrical use:	Biomethane for pipeline injection or vehicle use.		

## FEEDSTOCK

Minimum and maximum inputs:	3,333 - 65,000 per reactor vessel	<input type="checkbox"/> tons per day	<input checked="" type="checkbox"/> tons per year
Acceptable moisture content	5 - 95 for each individual feedstock, from 18-55% for total recipe.		
Pretreatment required?	<input type="checkbox"/> no <input checked="" type="checkbox"/> If yes, Describe: Driven by size and contamination level of incoming waste, from none to extensive.		

Acceptable for System	Type of Feedstock	Predicted Volume Reduction, %
<input checked="" type="checkbox"/>	Livestock manure (3 to 10% total solids)	Depends on BVS
<input checked="" type="checkbox"/>	Livestock manure (>10% total solids)	Depends on BVS
<input checked="" type="checkbox"/>	Food wastes	Depends on BVS
<input checked="" type="checkbox"/>	Organic matter separated from municipal solid wastes	Depends on BVS
<input checked="" type="checkbox"/>	Non-woody yard wastes	Depends on BVS
<input checked="" type="checkbox"/>	Other organic wastes: Crop residuals, soiled paper, cardboard, ICI sludges.	Depends on BVS
Comments:	BVS is biodegradable volatile solids. OWS felt this section was too broad to answer with any specifics.	

## OUTPUT / DIGESTATE

Not enough information provided by the vendor to complete this section.

## OPERATION AND MAINTENANCE REQUIREMENTS

	Low	Medium	High	Hours per week (if known)	Comment
Operator Expertise	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
Seasonal Issues	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Labor					
Receiving	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Depends on feedstock composition, quantity.
Loading	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Automated.
Unloading	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Automated.
Storage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Automated.
Curing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Automated.
Pretreatment	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		When required.
Mixing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Automated, external to digester.
Process monitoring	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Automated.
Engine and generator set maintenance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1	
Biogas processing equipment maintenance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Residue management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Depends on original feedstock and use of digestate.
Further processing of gas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Depends on whether biogas is used for electrical generation or biomethane production.
Further processing of Digestate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Depends on what is needed by client.
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Size of plant and feedstock assumptions will determine O&M. DRANCO plants can be run on 1-3 shifts per day, depending on client requirements and desires. DRANCO farm can be configured to reduce daily labor to < 3 hours.

**Total Labor Per Week (sum of above):**

## POTENTIAL NUISANCE CONCERNS AND MITIGATION MEASURES

	Low	Medium	High	Description of Nuisance	Mitigation Measures
Odors	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Arrival of waste, aerobic stabilization if done in open area.	Empty trucks inside receiving hall, close door after departure. Use closed hall with negative air flow and biofilter.
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Arrival and departure of trucks.	No jake breaking, horns, back-up alarms. Use enclosed hall.
Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Aerobic composting phase.	Use closed hall with biofilter.
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

## SYSTEM EXPENSES

Capital costs:	Depends on scale and scope.	Cost for routine maintenance and supplies:	Depends on scale and scope.	
Shipping and installation:	Included in cost.	Dealer service call cost:	\$	Warranty cost (if available): \$
Warranty availability and features (if available):	1-3 years			
Expected life of systems	25+ years			
Financing options offered:	<input checked="" type="checkbox"/> Lease	<input checked="" type="checkbox"/> Buy	<input type="checkbox"/> Other: Willing to coinvest in select projects.	

## VENDOR INFORMATION

System manufacturer:	Name: OWS	Telephone: 513-535-6760
	Address: 7155 Five Mile Road Cincinnati, OH 45230	Email: norma.mcdonald@ows.be
		Website: www.ows.be
U.S. representative (if foreign country):	Name:	Telephone:
	Address:	Email:
		Website:
Vendor description of company:	OWS is a privately held company specializing in designing and building dry continuous anaerobic digester systems for the organic fraction of municipal, industrial, commercial, and institutional waste streams, as well as agricultural residuals. OWS has been under consistent ownership and management for 25 years, headquartered in Belgium with US operations since 1992, as well as having affiliates in Japan and Germany. OWS has 75 employees, more than half of whom are engineers.	
Year company established:	1988	
Other equipment or business:	OWS is a world-wide accredited, ISO 17025 laboratory providing testing and consulting services for waste analysis, biodegradation, compostability, and biogas consultancy.	

## VENDOR SERVICES

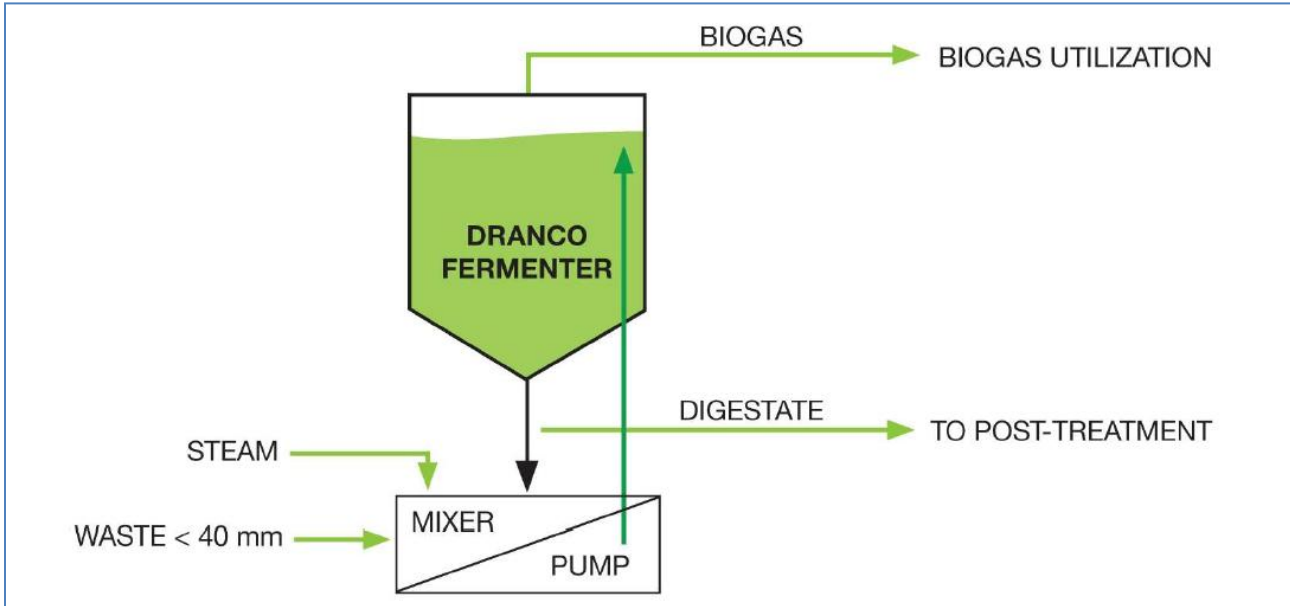
	Yes	No	Description
Site preparation:	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
System start-up	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Gas processing equipment and Engine-generator set repair:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Via other equipment providers, but OWS has extensive experience with biogas upgrading, electrical generation and waste heat utilization.
Technical support:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	OWS's laboratory and field technical support is available for start-up and ongoing operations, as well as to facilities built by others.

## OPERATING SYSTEMS

Number of operating systems:	28 mostly in Europe	Number of systems under construction:	4
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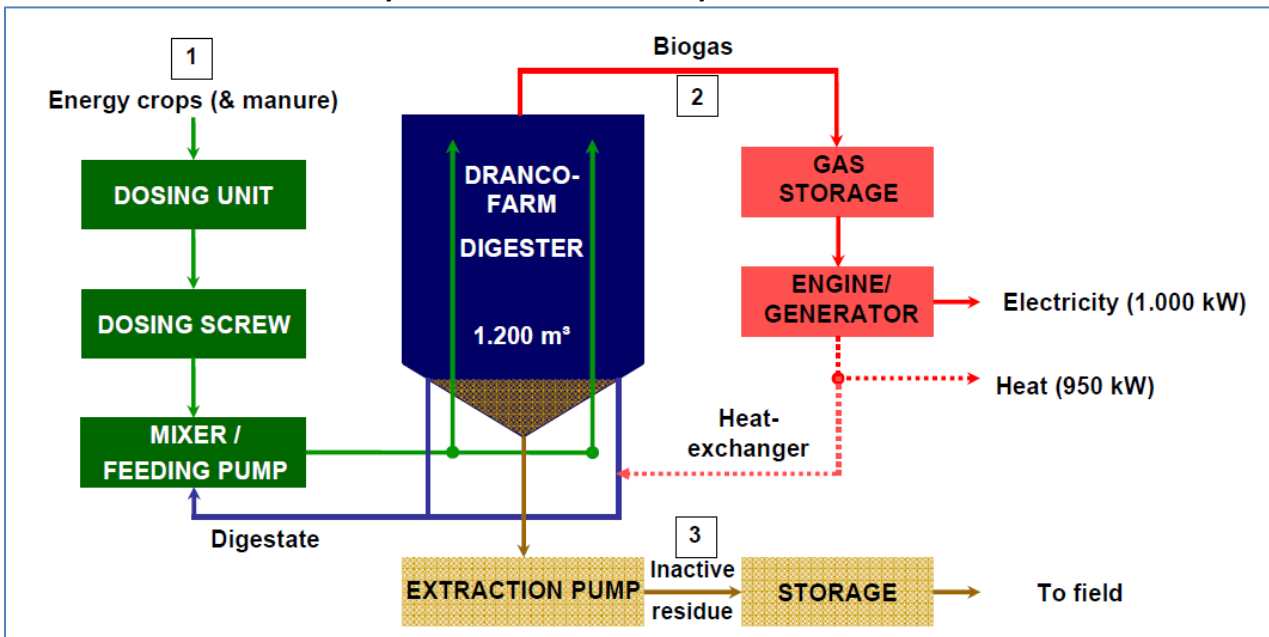
# SCHEMATIC

## Basic DRANCO Process Schematic



Source: <http://www.ows.be/wp-content/uploads/2013/02/The-DRANCO-technology-2012.pdf>

## DRANCO FARM Schematic for System in Nüstedt Germany



Source: <http://www.ows.be/wp-content/uploads/2013/02/The-DRANCO-technology-2012.pdf>

## Organics-To-Energy Small Technologies Evaluation Form

### GENERAL INFORMATION

Name of technology: powerQUBE

Vendor/brand name(s): powerQUBE

Type of technology:  Composting  Dry AD  Slurry/Wet AD

Process: Mixed mesophilic anaerobic digestion

Vendor description of technology: powerQUBE designs and builds micro anaerobic digesters that can be used to process a wide variety of feedstocks, such as food, animal, and green waste, into biogas. Each module comprises one 20-foot shipping container (the starter module) with differing numbers of modules to make up the unit's required retention time and digestion space. Small volumes of feedstock are loaded each day and the same volume is unloaded each day; this is automated. Each system contains a reception chamber, with macerator pump to mix feedstock and transfer to the digester; heat exchangers to keep the digesters at a set operating temperature to ensure rapid digestion and biogas production; control panel to automate pumps, heating and gas/generator controls; and biogas storage bladder.

### SUITABLE APPLICATIONS

Capped Landfills  Small Farm  Institutional/Campus

Operating Landfill  Co-Located with Composting Operation  Other:

Urban Settings  Food Manufacturer  NGO or developing country.

### REACTOR DETAILS

Operating volume 565 (each module) ft<sup>3</sup>

Processing capacity Varies by feedstock. The smallest system accepts 1,455 tons food/year (3.99 tons/day), or 49 tons fats and oils/year (0.13 tons/day).

Retention time 40 days (typically).

Operating type  Continuous

Footprint: 160 ft<sup>2</sup> per module.

Physical structure:  Prefabricated (modular)

Describe: System is housed in series of 20-foot shipping containers and is fully modular.

## HOST FACILITY REQUIREMENTS

Describe structural requirements (e.g., a concrete pad for prefabricated systems):

Firm, level base (i.e., hard core).

	Yes	No		Describe
Utility connections				
Electrical interconnection to the grid	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		Can operate with grid connection or in "island mode."
Water supply	<input checked="" type="checkbox"/>	<input type="checkbox"/>	10% by volume	Water demand depends on feedstock composition, but may require 10% by volume.
Sewer connection	<input type="checkbox"/>	<input checked="" type="checkbox"/>		
Operational equipment necessary, but not included (e.g. solids separator)	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Solid separator, pasteurizer if required, feed macerator.
Buildings and structures required for equipment and operations	<input type="checkbox"/>	<input checked="" type="checkbox"/>		
Other outdoor area required for operations (e.g. containment pond)	<input checked="" type="checkbox"/>	<input type="checkbox"/>		Biogas storage bladder, digestate storage.

## BIOGAS UTILIZATION

Equipment included?	Generator set and biogas cleaning technology, both optional.
Interconnect switching included?	Yes. Sized depending on connection.
Type of biogas processing (e.g. drying, H <sub>2</sub> S scrubbing):	H <sub>2</sub> S scrubbing, moisture trap/adsorption.
Engine-generator set make/model:	
Capacity (kW), voltage, and single or three phase:	3.2kW - 15kW, single to three phase.
Non-electrical use:	Heating/cooking/biomethane upgrade for vehicle fuel.

## FEEDSTOCK

Minimum and maximum inputs:	0.5 - 4.5 <input checked="" type="checkbox"/> tons per day <input type="checkbox"/> tons per year
Acceptable moisture content	30 - 90 %
Pretreatment required?	<input checked="" type="checkbox"/> no <input type="checkbox"/> If yes, Describe:

Acceptable for System	Type of Feedstock	Predicted Volume Reduction, %
<input checked="" type="checkbox"/>	Livestock manure (3 to 10% total solids)	8 %
<input checked="" type="checkbox"/>	Livestock manure (>10% total solids)	8 %
<input checked="" type="checkbox"/>	Food wastes	11 %
<input checked="" type="checkbox"/>	Organic matter separated from municipal solid wastes	9 %
<input checked="" type="checkbox"/>	Non-woody yard wastes	9 %
<input checked="" type="checkbox"/>	Other organic wastes:	- %
Other:		



## OUTPUT / DIGESTATE

Required holding capacity:

Comment: Depends on storage and local spreading capability. A pastuerizer may be used to sanitize the digestate before it is land applied.

Type of Digestate	Quantity	Characteristics	Uses/Disposal Options
Liquid		Depends on composition and solid to liquid separator requirements.	Fertilizer/spread to land.
Solid		Depends on composition and solid to liquid separator requirements.	Fertilizer/spread to land.
Combined Liquid/Solid		Depends on composition and solid to liquid separator requirements.	Fertilizer/spread to land.

## OPERATION AND MAINTENANCE REQUIREMENTS

	Hours per week (if known)			Comment
	Low	Medium	High	
Operator expertise	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Seasonal issues	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Labor				
Receiving	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Loading	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Unloading	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Storage	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Curing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Pretreatment	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Mixing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Process monitoring	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Engine and generator set maintenance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Biogas processing equipment maintenance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Residue management	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Further processing of gas	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Further processing of digestate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Total Labor Per Week (sum of the above):</b>				3 hr/week

## POTENTIAL NUISANCE CONCERNS AND MITIGATION MEASURES

	Low	Medium	High	Description of Nuisance	Mitigation Measures
Odors	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	System is fully encapsulated.	
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	With CHP running, noise at < 56 dBLEq at 10m.	
Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Oxides of nitrogen: 500 mg/m <sup>3</sup> . CO: 1,400 mg/m <sup>3</sup> . SO <sub>2</sub> : 350 mg/m <sup>3</sup> . Total VOC including CH <sub>4</sub> : 1,000 mg/m <sup>3</sup> .	
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

## SYSTEM EXPENSES

Vendor requested cost information not be included in Directory.

## VENDOR INFORMATION

System manufacturer:	Name: <u>powerQUBE</u>	Telephone: <u>+44 (0) 1984 624989</u>
	Address: <u>Higher Ford</u>	Email: <u>enquiries@powerqube.co.uk</u>
	<u>Wiveliscombe</u>	
	<u>Somerset</u>	Website: <u>http://www.powerqube.co.uk/</u>
	<u>TA4 2RL</u>	
	<u>United Kingdom</u>	
U.S. representative (if foreign country):	Name: <u>Energy Price Management Group, LLC</u>	Telephone: <u>917-525-2597</u>
	Address: <u>399 1/2 Main St</u>	Email: <u>savings@energyPMG.com</u>
	<u>Dalton, MA 01226</u>	Website: <u>www.EnergyPMG.com</u>
Vendor description of company:	<u>powerQUBE designs and builds micro anaerobic digesters that can be used to process a wide variety of biodegradable wastes, feedstocks and underutilized resources into biogas. powerQUBE is park of Aardvark EM Limited, which has been involved with small- and large-scale AD systems for over 20 years.</u>	
Year company established:	<u>2012</u>	
Other equipment or business:	<u>N/A</u>	

## VENDOR SERVICES

	Yes	No	Description
Site preparation:	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<u>Firm level base required.</u>
System start-up	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Gas processing equipment and Engine-generator set repair:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<u>CHP warrantied for 12 months. Digester warrantied for 5 years.</u>
Technical support:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<u>Provided for first 12 months of operation.</u>

## OPERATING SYSTEMS

Number of operating systems: 2 Number of systems under construction: \_\_\_\_\_

### Systems Currently in Operation in the U.S. and Canada:

<b>Name of site</b>	<b>Name of Owner/Operator</b>	<b>Address:</b>
<b>1</b>	The Green	Somerset, England
Date system began operating:	March 2012	
Brief Description (including size of system, waste being processed and processed waste disposal):	NOTE: This system is operating in the UK. 3.2kW CHP processing horse manure and food waste.	
<b>2</b>	Howard Tenens	Wiltshire, England
Date system began operating:	July 2013	
Brief Description (including size of system, waste being processed and processed waste disposal):	NOTE: This system is operating in the UK. 7kW equivalent. Biomethane upgrade plant to provide vehicle fuel.	

## SCHEMATIC

Schematic not available.



**TECHNOLOGY REVIEW PERFORMED BY:**

Eastern Research Group, Inc. SM/CI  
 Work Order 13-1 to Mass CEC  
 Date Completed: 03/13/2013

**Organics-To-Energy Small Technologies Evaluation Form**

**GENERAL INFORMATION**

Name of technology: The MUCKBUSTER®  
 Vendor/brand name(s): SEaB Energy  
 Type of technology:  Composting  Dry AD  Slurry/Wet AD  
 Process: Mixed mesophilic anaerobic digestion  
 Vendor description of technology: MUCKBUSTER is a factory-built anaerobic digestion system designed to process animal manure, organic waste, or septic waste contained in a 40ft shipping container. The system processes all biological waste except wood, paper, and cardboard. The unit collects biogas in a separate 20ft container, which is fed through a CHP unit to produce electricity and heat.

**SUITABLE APPLICATIONS**

- Capped Landfills
- Operating Landfill
- Urban Settings
- Small Farm
- Co-Located with Composting Operation
- Food Manufacturer
- Institutional/Campus
- Other:

**REACTOR DETAILS**

Operating volume: 198 - 1,102 ft<sup>3</sup>  
 Processing capacity: 0.55 - 11 tons/day  
 Retention time: 15 days  
 Operating type:  Continuous  
 Footprint: 345 ft<sup>2</sup>  
 Physical structure:  Prefabricated (modular)  
 Describe: Fully prefabricated, modular system contained within one or more 40ft shipping containers. The system also includes a separate 20ft container and CHP unit to collect biogas and produce electricity and heat.

**HOST FACILITY REQUIREMENTS**

Describe structural requirements (e.g., a concrete pad for prefabricated systems): Concrete pad/hard standing required and fenced area for security reasons.

	Yes	No	Describe
Utility connections			
Electrical interconnection to the grid	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<u>Varies depending on size of system.</u>
Water supply	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<u>Varies depending on size of system.</u>
Sewer connection	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

## HOST FACILITY REQUIREMENTS

	Yes	No	Describe:
Operational equipment necessary, but not included (e.g. solids separator)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	_____
Buildings and structures required for equipment and operations	<input type="checkbox"/>	<input checked="" type="checkbox"/>	_____
Other outdoor area required for operations (e.g. containment pond)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	_____

## BIOGAS UTILIZATION

Equipment included?	Gas storage bag and CHP unit/gas turbine.
Interconnect switching included?	_____
Type of biogas processing (e.g. drying, H <sub>2</sub> S scrubbing):	H <sub>2</sub> S inline scrubbing (included).
Engine-generator set make/model:	CHP 8-50kW unit or gas turbine 30-65kW unit.
Capacity (kW), voltage, and single or three phase:	Small units are around 8-21kW single phase; large units are 21-50kW, 3 phase.
Non-electrical use:	_____

## FEEDSTOCK

Minimum and maximum inputs:	0.5 - 11 <input checked="" type="checkbox"/> tons per day
Acceptable moisture content	0 - 90 %
Pretreatment required?	<input type="checkbox"/> no <input checked="" type="checkbox"/> If yes, Describe: If very wet (i.e., 90-100% moisture), waste needs to be de-watered before entering the system.

Acceptable for System	Type of Feedstock	Predicted Volume Reduction, %
<input checked="" type="checkbox"/>	Livestock manure (3 to 10% total solids)	90-95 %
<input checked="" type="checkbox"/>	Livestock manure (>10% total solids)	90-95 %
<input checked="" type="checkbox"/>	Food wastes	90-95 %
<input checked="" type="checkbox"/>	Organic matter separated from municipal solid wastes	90-95 %
<input checked="" type="checkbox"/>	Non-woody yard wastes	90-95 %
<input checked="" type="checkbox"/>	Other organic wastes: Wood.	0-1 %

Comments: All wood should be pre-chipped to 5mm in size (i.e., wood shavings are fine).

## OUTPUT / DIGESTATE

Required holding capacity: 141 ft<sup>3</sup> Comment: Output is liquid fertilizer; the system separates solids from liquids.

Type of Digestate	Quantity	Characteristics	Uses/Disposal Options
Liquid	3,560-17,650 ft <sup>3</sup> per year	Liquid - no particles.	Liquid fertilizer.
Solid	9-182.5 tons per ton input	5-10% of material input.	Can be dried and used as animal bedding or mulch.
Combined Liquid/Solid			

## OPERATION AND MAINTENANCE REQUIREMENTS

	Hours per week (if known)			Comment
	Low	Medium	High	
Operator expertise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Only requirement is to input waste into the hopper attachment.
Seasonal issues	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Seasonal waste stream changes may change gas output.
Labor				
Receiving	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SEaB Energy will provide engineers to complete the installation.
Loading	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3.5
Unloading	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	User presses button to unload liquid, solid element is automatically unloaded.
Storage	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Curing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Pretreatment	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The system treats the waste automatically.
Mixing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The system mixes the waste automatically.
Process monitoring	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Remote monitoring software can dial into the unit to see temperatures, pressures, and levels.
Engine and generator set maintenance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	CHP requires seven services/year, totaling seven days per year. A gas turbine only requires one service per year.
Biogas processing equipment maintenance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Six-month and one-year service. Total time requirement of two days per year.
Residue management	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No residue left over.
Further processing of gas	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The system automatically processes the gas produced.
Further processing of digestate	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Liquid fertilizer is ready for land application.
Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Total Labor Per Week (sum of the above):</b>				<b>3.5 hr</b>

## POTENTIAL NUISANCE CONCERNS AND MITIGATION MEASURES

	Low	Medium	High	Description of Nuisance	Mitigation Measures
Odors	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No smell.	System uses high-tech filtration system.
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	65-85 decibels.	Can be housed in soundproof container if required.
Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	CO <sub>2</sub> release.	
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

## SYSTEM EXPENSES

Capital costs:	\$ 186,000 - 625,000	Cost for routine maintenance and supplies:	\$ 10,000 - 20,000 over lifetime of the system.
Brief description of costs above (what size system was assumed, what equipment is included, etc)	Capital costs do not include shipping or installation costs, which vary depending on site location.		
Shipping and installation:	\$ 1,000 (shipping per container, 3-7 required), plus \$7,500 (installation)	Dealer service call cost:	\$
Warranty availability and features (if available):	Two-year limited manufacturer's warranty, with 1-, 2-, or 3-year extension options. Installation warranty is separate.		
Expected life of systems	20 years		
Financing options offered:	<input checked="" type="checkbox"/> Lease	<input checked="" type="checkbox"/> Buy	<input checked="" type="checkbox"/> Other: Project finance.

## VENDOR INFORMATION

System manufacturer:	Name: <u>SeaB Energy</u>	Telephone: <u>+442380 111 909</u>
	Address: <u>2 Venture Road</u>	Email: <u>info@seabenergy.com</u>
	<u>Southampton Science Park</u>	
	<u>Southampton</u>	Website: <u>http://www.seabenergy.com</u>
	<u>SO16 7NP</u>	
	<u>United Kingdom</u>	
U.S. representative (if foreign country):	Name: _____	Telephone: _____
	Address: _____	Email: _____
		Website: _____
Vendor description of company:	SEaB Energy Limited is a UK-based company working in the renewable energy and energy from waste sectors. The company is located at the University of Southampton Science Park in Chilworth on the outskirts of Southampton.	
Year company established:	<u>2008</u>	
Other equipment or business:	<u>FLEXIBUSTER system: The Flexibuster is a self-contained anaerobic digester, designed to process food and organic waste.</u>	

**VENDOR SERVICES**

Site preparation:

Yes  No

**Description**

Will organize all ground works to be completed before unit delivery.

System start-up

Yes  No

Will remain on site until the system starts to run in fully automatic mode.

Gas processing equipment and Engine-generator set repair:

Yes  No

If any issues arise, SEaB Energy or an official partner provides all servicing of the equipment.

Technical support:

Yes  No

SEaB Energy has a 24-hour technical support line.

**OPERATING SYSTEMS**

Number of operating systems: 2 Number of systems under construction: 5

**Systems Currently in Operation in the U.S. and Canada:**

Name of site	Name of Owner/Operator	Address:
1 Science Park	University of Southampton/SEaB Energy	University of Southampton Science Park Chilworth, Southampton, Hants SO16 7NP United Kingdom

Date system began operating: May 2012

Brief Description (including size of system, waste being processed and processed waste disposal):

NOTE: This system is in the UK and is a demonstration unit.  
System is a standard MUCKBUSTER SEaB MB400 containerized anaerobic digestion system. Feedstock is a combination of kitchen food waste, cooking oil, spent alcoholic drinks, and landscape green waste. The system runs an 8kW CHP unit and produces an average of 46m<sup>3</sup>/day of methane, which provides 35MWh/year of electricity.

**SCHEMATIC**

Schematic not available.



## Organics-To-Energy Small Technologies Evaluation Form

### GENERAL INFORMATION

Name of technology: BioBeetle

Vendor/brand name(s): Spectrum BioEnergy

Type of technology:  Composting  Dry AD  Slurry/Wet AD

Process: Mixed mesophilic anaerobic digestion

Vendor description of technology: The BioBeetle is a packaged, modular biogas plant system designed for the micro-to-small-scale waste market. The system converts up to 5 tons of feedstock per day. The BioBeetle has operated as a demonstration unit in Albany, New York, and Millstone, New Jersey, and currently operates in India.

### SUITABLE APPLICATIONS

Capped Landfills  Small Farm  Institutional/Campus

Operating Landfill  Co-Located with Composting Operation  Other:

Urban Settings  Food Manufacturer

### REACTOR DETAILS

Operating volume: ft<sup>3</sup>

Processing capacity: 0.5 - 5  tons/day

Retention time: 30-40 days

Operating type:  Continuous

Footprint: ft<sup>2</sup>

Physical structure:  Prefabricated (modular)

Describe: Each half-ton plant is housed in a 40ft shipping container; system can be up to 5 tons.

### HOST FACILITY REQUIREMENTS

Describe structural requirements (e.g., a concrete pad for prefabricated systems): Pad for prefabricated systems. Doesn't have to be concrete (rocks, asphalt, cement). Flare unit will also need to be installed.

## HOST FACILITY REQUIREMENTS

	Yes	No	Describe
Utility connections			
Electrical interconnection to the grid	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Water supply	<input checked="" type="checkbox"/>	<input type="checkbox"/>	In a complete mix system, minimal fresh water needed (50-70% of digestate recirculates). However, some fresh water may be needed depending on system mechanics.
Sewer connection	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Operational equipment necessary, but not included (e.g. solids separator)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Buildings and structures required for equipment and operations	<input type="checkbox"/>	<input type="checkbox"/>	Depends on host.
Other outdoor area required for operations (e.g. containment pond)	<input type="checkbox"/>	<input type="checkbox"/>	Depends on host needs. Generally, small-scale doesn't require any other outdoor space.

## BIOGAS UTILIZATION

Equipment included?	Flare unit, generator are optional, but can be included.
Interconnect switching included?	N/A
Type of biogas processing (e.g. drying, H <sub>2</sub> S scrubbing):	H <sub>2</sub> S scrubbing included.
Engine-generator set make/model:	Efficiency _____ %
Capacity (kW), voltage, and single or three phase:	1.5kW minimum capacity.
Non-electrical use:	Preferable for gas to be used directly (such as for a water heater), instead of electricity, due to efficiency loss when using generator.

## FEEDSTOCK

Minimum and maximum inputs:	0.5 - 5 tons per day
Acceptable moisture content	87 - 92 %
Pretreatment required?	<input checked="" type="checkbox"/> no <input type="checkbox"/> If yes, Describe:

Acceptable for System	Type of Feedstock	Predicted Volume Reduction, %
<input checked="" type="checkbox"/>	Livestock manure (3 to 10% total solids)	%
<input checked="" type="checkbox"/>	Livestock manure (>10% total solids)	%
<input checked="" type="checkbox"/>	Food wastes	%
<input checked="" type="checkbox"/>	Organic matter separated from municipal solid wastes	%
<input type="checkbox"/>	Non-woody yard wastes	%
<input type="checkbox"/>	Other organic wastes:	%

Comments: Vendor is not able to provide estimates on volume reduction because pilot projects have used a mix of feedstocks that varied from day to day. Volume reduction is highly variable, depending on the feedstock mix used.

## OUTPUT / DIGESTATE

Required holding capacity:

Comment: Minimum 300 gallon holding tank.

### Type of

Digestate	Quantity	Characteristics	Uses/Disposal Options
Liquid		N/A. No solids separation.	
Solid		N/A. No solids separation.	
Combined Liquid/Solid		3-5% solids, 2/3 proportion of digestate to inputs.	Can recycle 50-70%.

## OPERATION AND MAINTENANCE REQUIREMENTS

	Hours per week (if known)			Comment
	Low	Medium	High	
Operator expertise	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Initial operator training required.
Seasonal issues	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Cold weather can impact system operations.
Labor				
Receiving	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Loading	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Unloading	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Storage	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Curing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Pretreatment	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Mixing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Process monitoring	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Engine and generator set maintenance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Biogas processing equipment maintenance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Residue management	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Further processing of gas	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Further processing of digestate	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Total Labor Per Week (sum of above):</b>			10-20 hr	

## POTENTIAL NUISANCE CONCERNS AND MITIGATION MEASURES

	Low	Medium	High	Description of Nuisance	Mitigation Measures
Odors	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

## SYSTEM EXPENSES

Capital costs:	\$ 100,000 (approximate)	Cost for routine maintenance and supplies:	\$ 5,000 per year
Brief description of costs above (what size system was assumed, what equipment is included, etc)	Estimated cost corresponds to average cost associated with demonstration units. Capital cost includes H <sub>2</sub> S scrubbing, but not flare unit or generator.		
Shipping and installation:	\$ 5,000 (including training costs)	Dealer service call cost: \$	Warranty cost (if available): \$
Warranty availability and features (if available):			
Expected life of systems	20 years		
Financing options offered:	<input checked="" type="checkbox"/> Lease <input checked="" type="checkbox"/> Buy <input type="checkbox"/> Other: _____		

## VENDOR INFORMATION

System manufacturer:	Name: <u>Spectrum BioEnergy LLC</u>	Telephone: <u>301-452-5084</u>
	Address: <u>Brooklyn, New York</u>	Email: <u>info@spectrumbioenergy.com</u>
		Website: <u>spectrumbioenergy.com/index.php/bio-beetle</u>
U.S. representative (if foreign country):	Name: _____	Telephone: _____
	Address: _____	Email: _____
		Website: _____
Company description:	<u>Spectrum BioEnergy (SBE) offers technological solutions for small- to large-scale waste producers through the BioBeetle Anaerobic Digestion Systems and medium- to large-scale Biogas Projects.</u>	
Year company established:	<u>2010</u>	
Other equipment or business:	<u>Spectrum BioEnergy also develops large-scale biogas projects, including US systems</u>	

## VENDOR SERVICES

	Yes	No	Description
Site preparation:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<u>In collaboration with site owner/manager.</u>
System start-up	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____
Gas processing equipment and Engine-generator set repair:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	_____
Technical support:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<u>In collaboration with local personnel.</u>

## OPERATING SYSTEMS

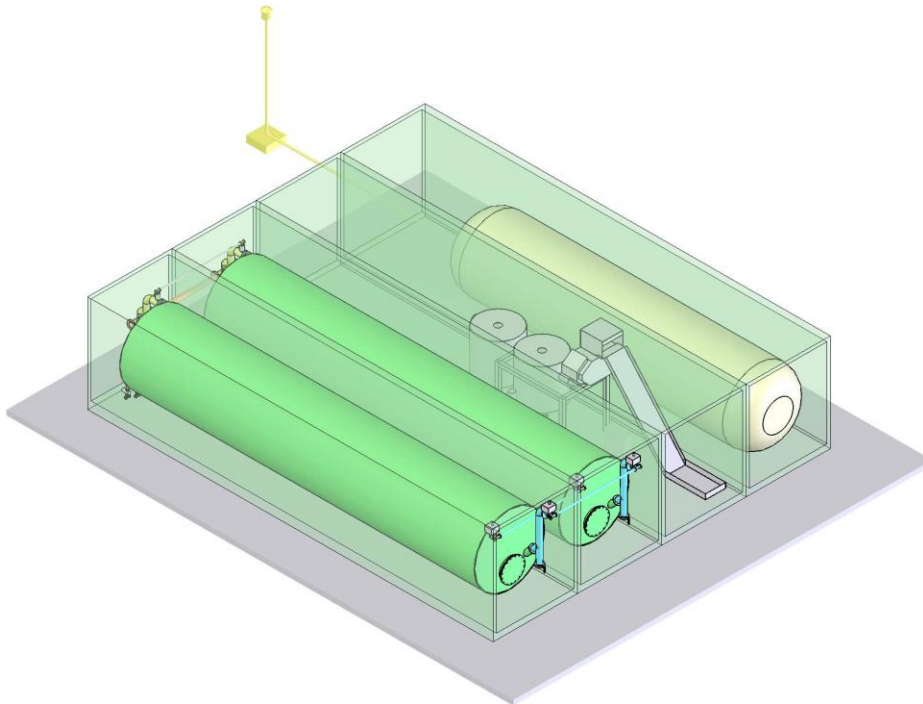
Number of operating systems: 3 (as demonstration units) in Albany, NY; Millstone, NJ; and India      Number of systems under construction: 0

### Systems Currently in Operation in the U.S. and Canada:

Name of site	Name of Owner/Operator	Address:
1 Albany County Wastewater Treatment Plant		Albany, New York
Date system began operating:	January - May 2012	
Brief description (including size of system, waste being processed and processed waste disposal):	Demonstration project processing 0.5 ton/day of wastewater biosolids, food waste, and fats, oil and grease. All possible waste was recycled and whatever wasn't recycled was processed through the wastewater treatment plant.	
2 Showplace Farms and Training Ground		Millstone Township, New Jersey
Date system began operating:	January - April 2013	
Brief description (including size of system, waste being processed and processed waste disposal):	Demonstration project processing up to 100 lb/day of equine manure combined with straw bedding or woody pellet bedding. All waste is recycled.	

## SCHEMATIC

### Schematic of 1.25 tons/day modular BioBeetle system



## Organics-To-Energy Small Technologies Evaluation Form

### GENERAL INFORMATION

Name of technology: SmartFerm

Vendor/brand name(s): Zero Waste Energy, LLC. (ZWE)

Type of technology:  Composting  Dry AD  Slurry/Wet AD

Process: Mixed thermophilic anaerobic digestion  
Mixed mesophilic anaerobic digestion

Vendor description of technology: Can scale from 5,000 to 20,000 tons/year by changing the configuration. Four key process phases: 1. Supply Air (Aeration); 2. Percolate Cycle; 3. Biogas System; and 4. Exhaust Air. The system is useful for decentralized, i.e., local, production of electricity and heat. Selective recycling of stackable substrates. Offer two options for the mode of operation: mesophilic and thermophilic.

### SUITABLE APPLICATIONS

Capped Landfills  Small Farm  Institutional/Campus

Operating Landfill  Co-Located with Composting Operation  Other:

Urban Settings  Food Manufacturer

Organic food and greenwaste from a normal MSW waste stream. Designed for the waste services industry.

### REACTOR DETAILS

Operating volume 65-75 tons/batch ft<sup>3</sup>

Processing capacity 5,000 tons to 20,000 tons/year

Retention time 21 days

Operating type  Batch

Footprint: Minimum footprint (5,000 ton system): 3,000 ft<sup>2</sup>. This includes CHP and biofilter. Doesn't increase in footprint linearly

Physical structure:  Prefabricated (modular)

Describe: The basic SmartFerm system design features four (4) steel fabricated and insulated tunnels, each 12 feet in width, 12 feet in height, and 40 feet in length, requiring a minimal amount of space. Each tunnel has a specially designed hatch that provides a gas-tight seal to ensure anaerobic conditions are properly maintained during processing. The base system also contains below-grade structural concrete percolate tank, a mechanical-electrical container, containerized CHP system, package bio-filter, external biogas storage bladder, and environmental control device.

## HOST FACILITY REQUIREMENTS

Describe structural requirements (e.g., a concrete pad for prefabricated systems): The operator is responsible only for preparing the foundation soil with the underground percolate storage and the foundation plate, including the required supply connections for water and electricity. ZWE will design and build the underground tank.

	Yes	No		Describe
Utility connections				
Electrical interconnection to the grid	<input checked="" type="checkbox"/>	<input type="checkbox"/>	480v 3 phase	Supplies its own once it's running. To start up, need to have electricity.
Water supply	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		The system is a net water user. Requires an initial water supply, but then recycles it. Can use water trucks.
Sewer connection	<input type="checkbox"/>	<input checked="" type="checkbox"/>		Depends on site and operational requirements.
Operational equipment necessary, but not included (e.g. solids separator)	<input type="checkbox"/>	<input checked="" type="checkbox"/>		Everything is self-contained. Can pre-process, but that's not necessary.
Buildings and structures required for equipment and operations	<input type="checkbox"/>	<input checked="" type="checkbox"/>		If odor control is desired, additional structures can be added, but aren't required.
Other outdoor area required for operations (e.g. containment pond)	<input type="checkbox"/>	<input checked="" type="checkbox"/>		If clients want a mixing area or hand sorting, they may want an outdoor area such as a shell or canopy, but this is optional.

## BIOGAS UTILIZATION

Equipment included?	<u>Yes. ZWE can furnish CHP, CNG, or combination thereof.</u>
Interconnect switching included?	<u>No. To be completed by customer. Technical support by ZWE.</u>
Type of biogas processing (e.g. drying, H <sub>2</sub> S scrubbing):	<u>For both CHP and CNG, ZWE includes moisture removal and H<sub>2</sub>S scrubbing.</u>
Engine-generator set make/model:	<u>2G Cenergy. MAN Engine. Depends on the project.</u> Efficiency <u>over 85 %</u> for CHP
Capacity (kW), voltage, and single or three phase:	<u>Varies on the project. Small system produces about 100kw 24/7.</u>
Non-electrical use:	<u>Heat, used locally for percolate heating.</u>

## FEEDSTOCK

Minimum and maximum inputs:	<u>5,000 - 20,000 tons per year</u>
Acceptable moisture content	<u>up to 75 %</u>
Pretreatment required?	<input checked="" type="checkbox"/> no <input type="checkbox"/> If yes, Describe:

Acceptable for System	Type of Feedstock	Predicted Volume Reduction, %
<input checked="" type="checkbox"/>	Livestock manure (3 to 10% total solids)	90 %
<input checked="" type="checkbox"/>	Livestock manure (>10% total solids)	50-60 %
<input checked="" type="checkbox"/>	Food wastes	30-35 %
<input checked="" type="checkbox"/>	Organic matter separated from municipal solid wastes	30-35 %
<input checked="" type="checkbox"/>	Non-woody yard wastes	30-35 %
<input checked="" type="checkbox"/>	Other organic wastes: Example: One facility takes residue from a calamari factory.	30-35 %

## FEEDSTOCK

Comments: If there is a high liquid content in feedstocks, the liquid is captured and recycled in the SmartFerm percolate tank and used for future percolation.

## OUTPUT / DIGESTATE

Required holding capacity:

Comment:

### Type of

Digestate	Quantity	Characteristics	Uses/Disposal Options
Liquid			
Solid			
Combined Liquid/Solid		90-92% of the inbound volume by weight. Approx. 70% moisture content.	Compost.

## OPERATION AND MAINTENANCE REQUIREMENTS

	Hours per week (if known)			Comment
	Low	Medium	High	
Operator expertise	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Digester loading/unloading with bucket truck.
Seasonal issues	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Labor				
Receiving	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Loading	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Unloading	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Storage	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Curing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Pretreatment	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Mixing	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Process monitoring	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Engine and generator set maintenance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Biogas processing equipment maintenance	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Residue management	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Further processing of gas	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Further processing of digestate	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<b>Total Labor Per Week (sum of above):</b>				<b>8-10 hr</b> Estimate is for the 4 digester SmartFerm. The 8 digester would be around 14 to 18 hours. A majority of operation time is digester unloading/loading and feedstock receiving; the balance is periodic system monitoring.



## POTENTIAL NUISANCE CONCERNS AND MITIGATION MEASURES

	Low	Medium	High	Description of Nuisance	Mitigation Measures
Odors	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Feedstock and digestate loading/unloading.	Location, enclosed receiving and digestate treatment facilities.
Noise	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	CHP	Sound-attenuated CHP.
Emissions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	NO <sub>x</sub> , SO <sub>2</sub> , VOCs, CO	Smartfarm and CHP designed. Post-combustion emission control option.
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

## SYSTEM EXPENSES

Capital costs:	<u>\$ 2,125,000</u>	Cost for routine maintenance and supplies:	<u>\$ 20,000-25,000 per year for the 4 digester SmartFarm system.</u>
Brief description of costs above (what size system was assumed, what equipment is included, etc)	<u>Costs are for the 4 digester SmartFarm system. Capital cost includes commissioning and training as well as a fully integrated 100kW CHP with biogas cooler and carbon filter skids.</u>		
Shipping and installation:	<u>\$ Varies by location and site.</u>	Dealer service call cost:	<u>\$</u>
Warranty availability and features (if available):	<u>2 year warranty</u>		
Expected life of systems	<u>10+ years</u>		
Financing options offered:	<input checked="" type="checkbox"/> Lease	<input checked="" type="checkbox"/> Buy	<input checked="" type="checkbox"/> <u>Other: ZWE can design, build, finance, own. There are no separate fees for this service; however, a long-term feedstock supply agreement is required for this financing option.</u>

## VENDOR INFORMATION

System manufacturer:	Name: <u>Environmental Solutions Group</u>	Telephone: <u>866-367-4345</u>
	Address: <u>2030 Hamilton Place Blvd</u>	Email: <u>corp@doveresg.com</u>
	<u>Suite 200</u>	Website: <u>www.doveresg.com</u>
	<u>Chattanooga, TN</u>	
U.S. representative (if foreign country):	Name: <u>Zero Waste Energy</u>	Telephone: <u>925-297-0600</u>
	Address: <u>3470 Mt. Diablo Blvd</u>	Email: _____
	<u>Suite A216</u>	Website: <u>www.zerowasteenergy.com</u>
	<u>Lafayette, CA</u>	
Vendor description of company:	<u>ZWE designs, builds, finances, and operates advanced waste management facilities that include material preprocessing, dry anaerobic digestion, and renewable energy applications.</u>	
Year company established:	<u>2010</u>	
Other equipment or business:	<u>NA</u>	

## VENDOR INFORMATION

### VENDOR SERVICES

	Yes	No	Description
Site preparation:	<input type="checkbox"/>	<input checked="" type="checkbox"/>	ZWE can provide design build services.
System start-up	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Gas processing equipment and engine-generator set repair:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Technical support:	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

### OPERATING SYSTEMS

Number of operating systems: 1 Number of systems under construction: 3

#### Systems Currently in Operation in the U.S. and Canada:

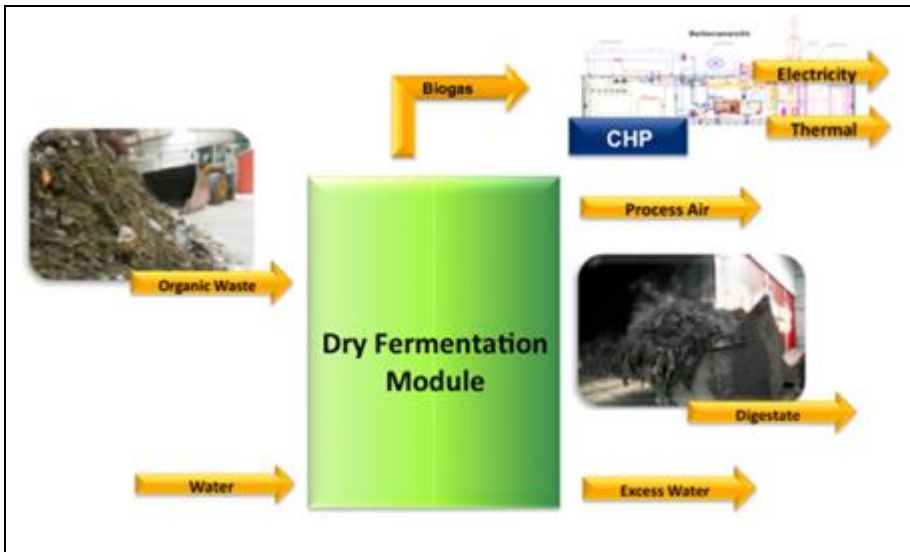
Name of site	Name of Owner/Operator	Address:
1 Marina Regional Waste Management District	ZWE	14201 Del Monte Blvd Marina, CA

Date system began operating: 3/8/2013

Brief description (including size of system, waste being processed and processed waste disposal): 5,000 ton/year Smartferm 100kw CHP. Commercial food waste.

### SCHEMATIC

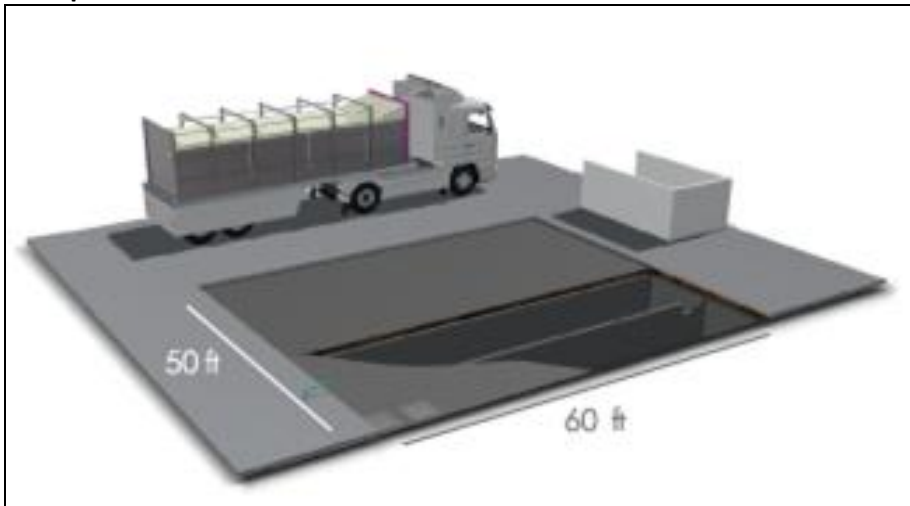
#### Basic SMARTFERM Process Schematic



Source: <http://www.zerowasteenergy.com/content/smartferm>

## SCHEMATIC

### Example SMARTFERM Floor Plan



Source: <http://www.zerowasteenergy.com/content/smartferm>