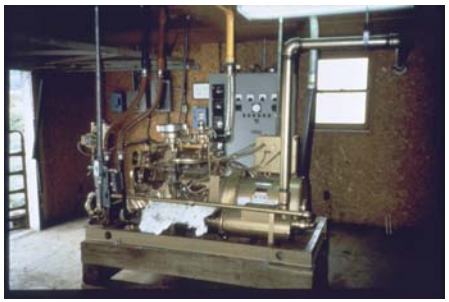
Reducing Methane Emissions from Livestock Waste for Energy Production and Pollution Control

A Global Perspective



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Presentation Overview

- Important considerations in waste management planning!
- What kinds of waste systems are there and how much methane do the emit?
- What are options that can reduce emissions?
- How do anaerobic digesters fit in and what makes them work?
- What benefits do they offer?
- What kinds of systems are there?
- How can gas be used?
- What types of project approaches are there?

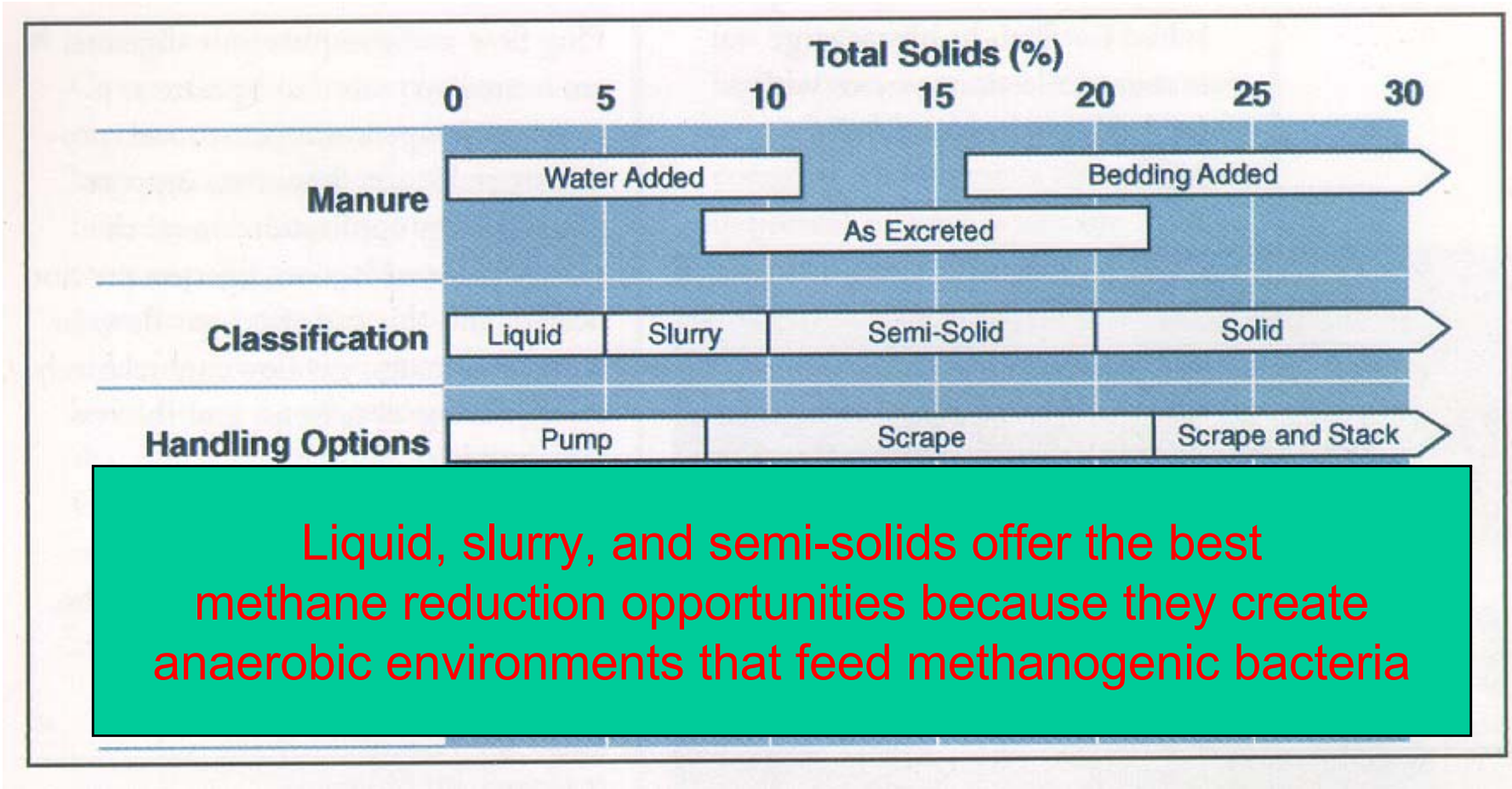
Waste System Considerations

- Livestock waste are high strength materials, comparatively 10-100 times stronger than sewage
- Wastes can pollute and cause disease when improperly disposed
- Main polluting elements:
  - High organic fraction (BOD and COD)
    - Fish kills – competes for dissolved oxygen
    - Odor attracts fly and other disease transmission vectors
    - Emits methane - greenhouse gas
  - Contain nutrients – nitrogen phosphorus and other
    - Causes eutrophication in surface waters
    - Can mutate plants when over applied or volatilized
  - Contain an array of bacteria, pathogens and other disease causing organisms
    - E. coli, Staph., Strep, Ascaris, etc.

- Livestock wastes are agricultural resources -

Challenge is to cost effectively manage wastes with consideration to human, water, air, and land impacts

Wastes are Handled in Different Ways



Methane Emissions are Dependent on Waste System

Factors effecting methane emissions:

1) Manure type
2) Manure handling (liquid, slurry, semi-solid, solid)
3) Temperature and time

AMWS Systems and Methane Emission Factor by Climate Type									
	Manure Management System								
Climate	*Lagoon*	*Liquid and Slurry*	*Solid Storage*	*Dry lot*	*Pit <1 month*	*Pit >1 month*	*Daily Spread*	*Digester*	*Other*
Cool	90%	10%	1%	1%	5%	10%	0.10%	10%	1%
Temperate	90%	35%	1.50%	1.50%	18%	35%	0.50%	10%	1%
Warm	90%	65%	2%	5%	33%	65%	1%	10%	1%

Calculating Methane Reductions

Example: 500 cow dairy with varying baseline waste management systems in a warm climate

	Waste System Types		
	Daily Spread	Liquid/Slurry Storage	Lagoon
(A) Baseline Farm - MCF	1%	65%	90%
Baseline Methane Emission - MT/yr	1.9	120.3	166.6
(B) MT Combusted CH_4/Year[1]	185	185	185
(C) MT CO_2 Utility Emission Offset (as CH_4)	32	32	32
(D) Refractory Emission[2] @1% biodegradable VS	1.9	1.9	1.9
MT Methane Reduction/Year[3]	0.0	-118.5	-164.8
as CO_2	0	-2,488	-3,460
as C_{arbon} $E_{quivalent}$	0	-679	-944

Notes:

[1] For this farm energy capacity is about 80 kW. Energy output is about 69 kWh/hr.

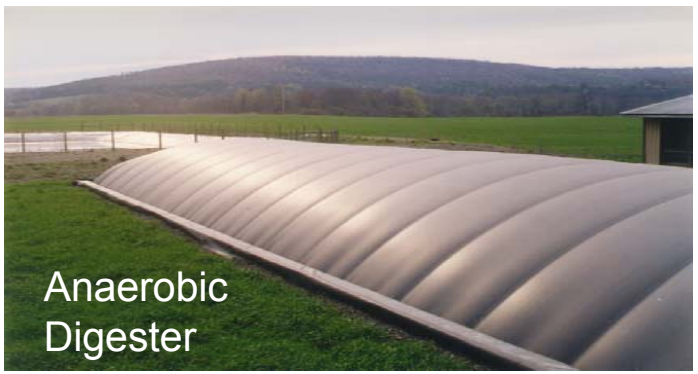
[2] Remaining biodegradale VS results in refractory emissions, assumed

[3] Positive value indicates increase in emission

Overview: Potential Methane Reducing Options

- Aeration – energy is used to provide oxygen to meet oxygen demand of waste (1 lbs. BOD requires 1 HP)
  - energy intensive and very expensive
  - used as tertiary treatment in sewage to meet discharge requirement
  - residual solids become problematic
  - Can produce nitrous oxide - much higher GWP
- Shifting liquid/slurry handling to solid manure handling
  - very limited because of scale
  - more economical to flush manure from confined production systems (pigs and dairy)
- Anaerobic digesters
  - consistent with farm waste handling objectives
  - oxygen demand satisfied anaerobically
  - produces biogas providing farm energy opportunities


Aeration


Anaerobic Digester

What are Anaerobic Digesters?

Biological treatment/stabilization systems that collect and combust off-gases.

Offer Air Quality benefits

- -Control odors from storage and field application
- -Reduces Greenhouse gases (methane)
- -Controls other emissions (H_2S, ammonia)

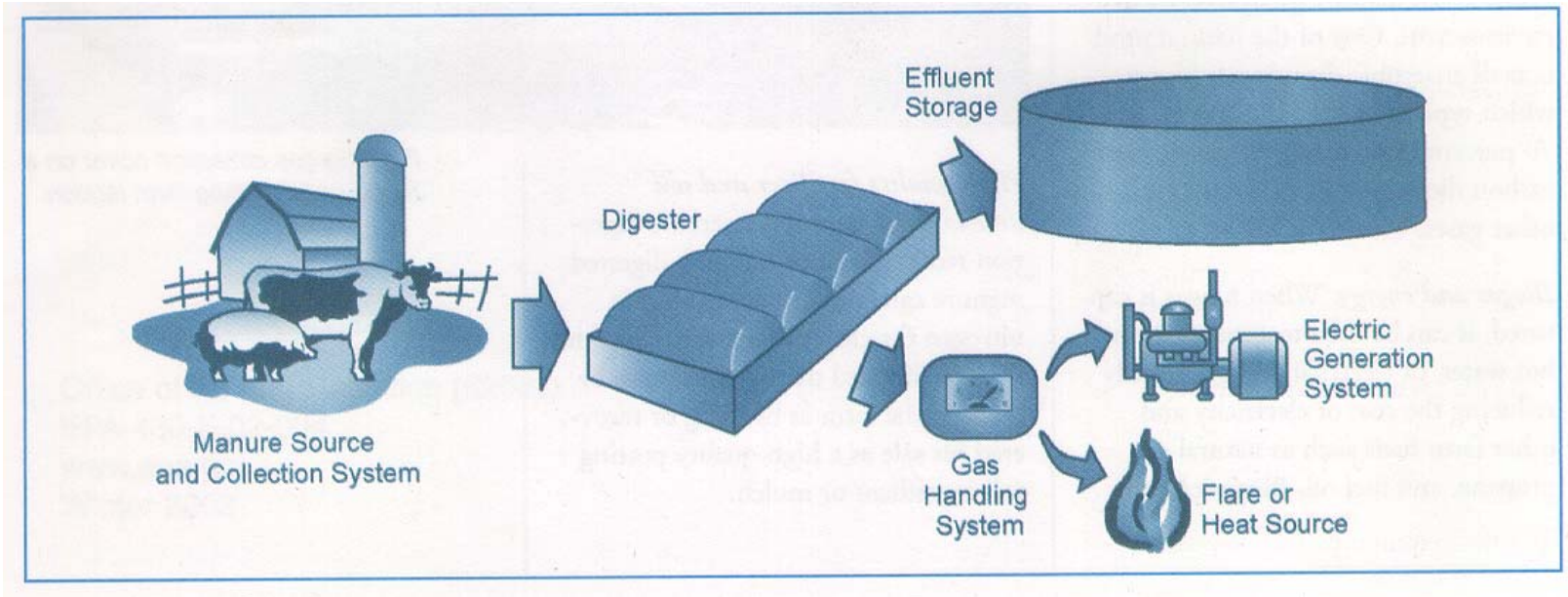
Offer Water Quality benefits

- -Stabilize manure organics (BOD)
- -Significantly reduce pathogens
- -Provide nutrient management predictability and flexibility

Offer return on Investment…….Energy revenues

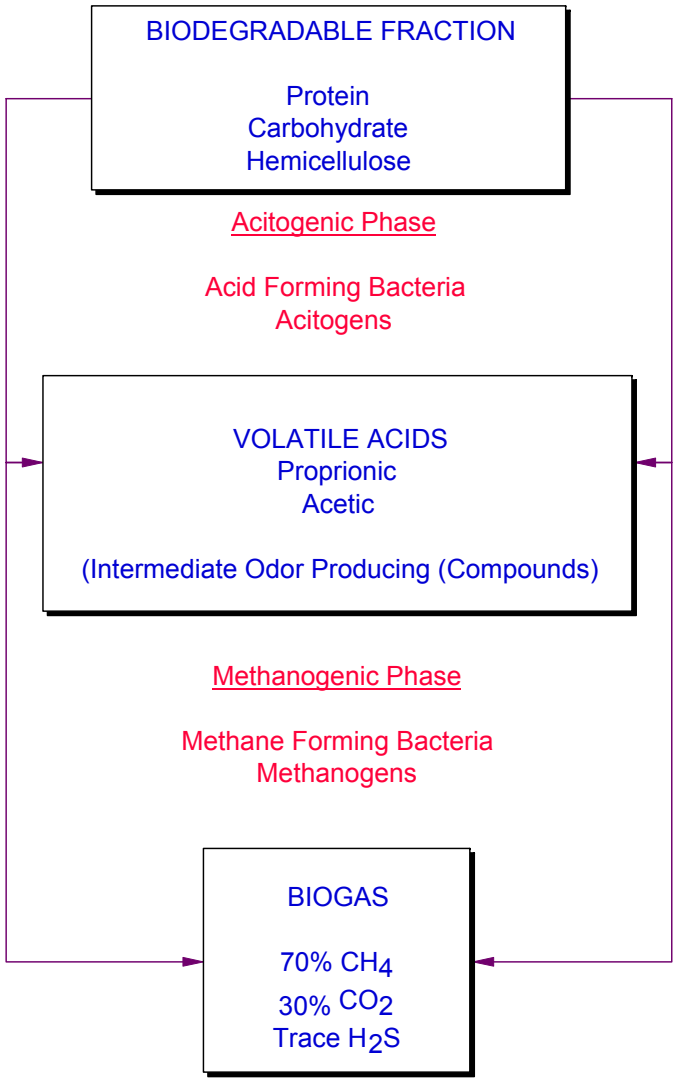
Anaerobic Digester Components

Digesters separate manure treatment from storage functions which can result in lower initial installation costs for new or expanding farms

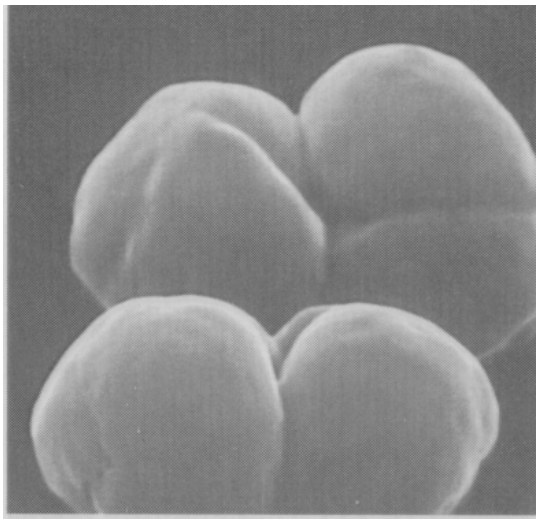


What Makes Digesters work?

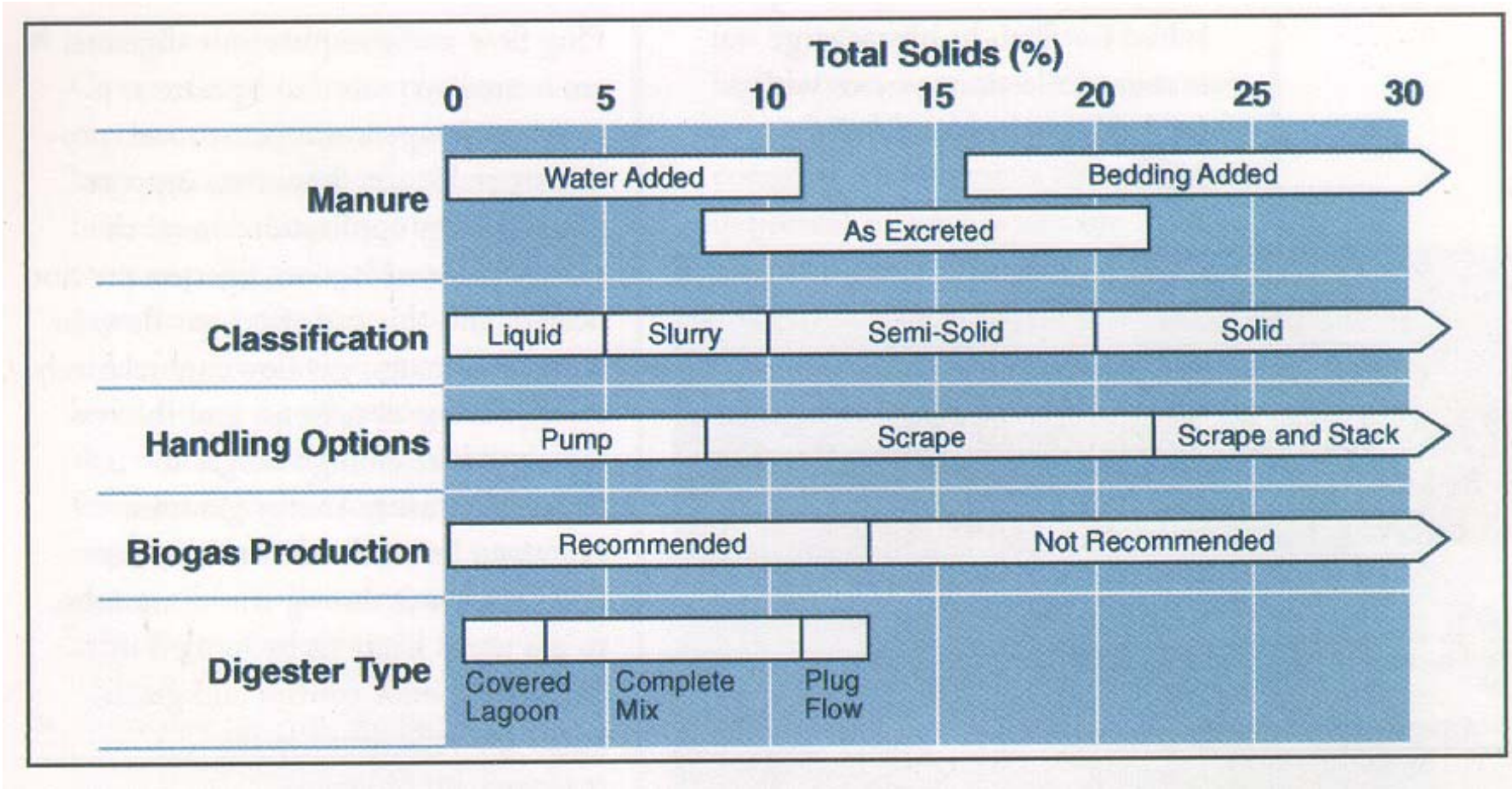
Anaerobic digestion is a biological process. It occurs in an oxygen free environment.



Methanogens



Digester Selection

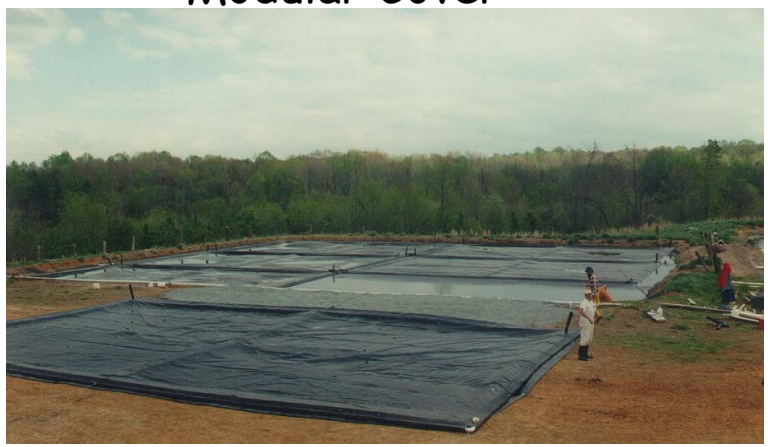


Unheated Digesters

Covered Lagoon Digester

Bank-to-Bank Cover

Modular Cover



Attached Media

More Unheated Digesters

Small - Intermediate Scale Digesters

Heated (Mesophilic) Mixed Digesters

Heated (Mesophilic) Plug Flow Digesters

Used for Dairy only w/ Separation

Gas Use: *Electrical Generation*

Recip. Engines 40-150kW

COMPONENTS

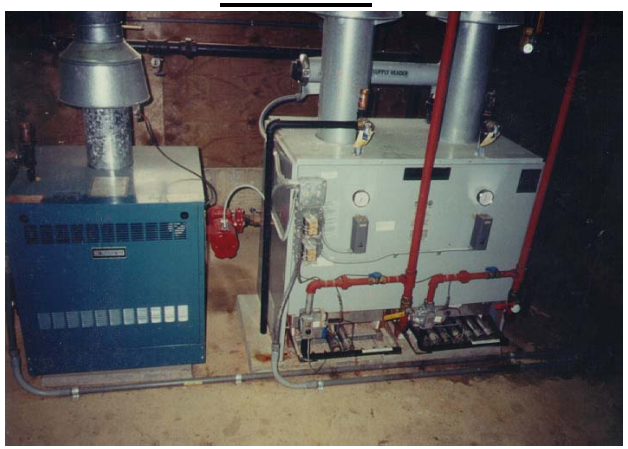
Gas Handling and Transmission

Engine Controller

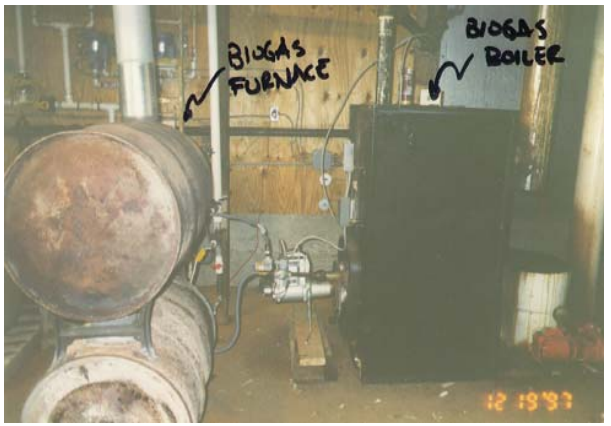
Electric Metering

Gas Use: *Heat*

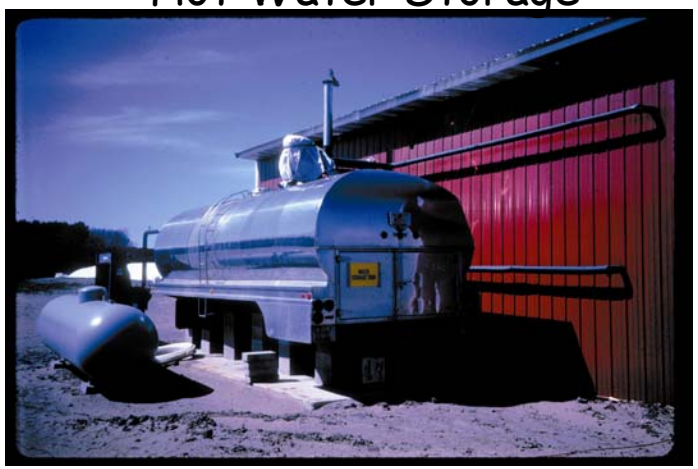
Boilers



Forced Air



Hot Water Storage

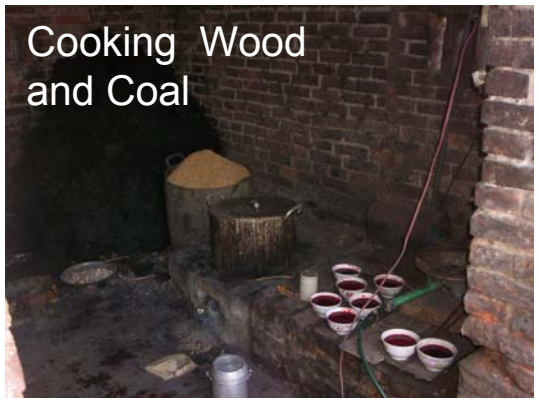


Hot Water Use

Gas Use: *Flares*

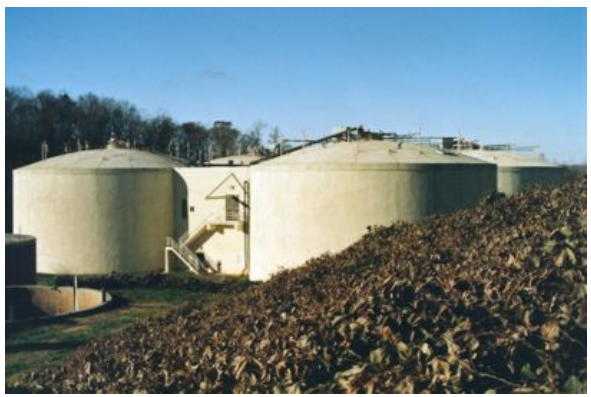
Odor Control and Greenhouse Gas Mitigation

Other Gas Use Options



Project Types

- On-Farm or Farm Scale: System is owned and operated by farm owner/manager
  - Currently the predominant project type in the U.S.
- Regional or Centralized Digesters: Off farm management and operation with a third party
  - Ideally located at a large energy (electric or heat) consuming source or interconnection point (feed mills or utility substation)



General Costs: *Livestock Basis*

Digester Type	Cost per Cow (1,400 lbs.)
Attached Media	$500-800
Complete Mix	$400-700
Covered Lagoon	$300-1,000
Plug Flow	$400-700

Swine equivalents: 4 sows = cow;10 feeder pigs = cow

Note: Cost assumes all manure is collected

Costs include engine gensets and separator (dairy systems)

Caution - Digesters Can Fail!

Gracias...