Challenges and Opportunities in Anaerobic Digestion: Maryland and the NE Experience

"Digester Systems in the NE: Successful Case Studies"

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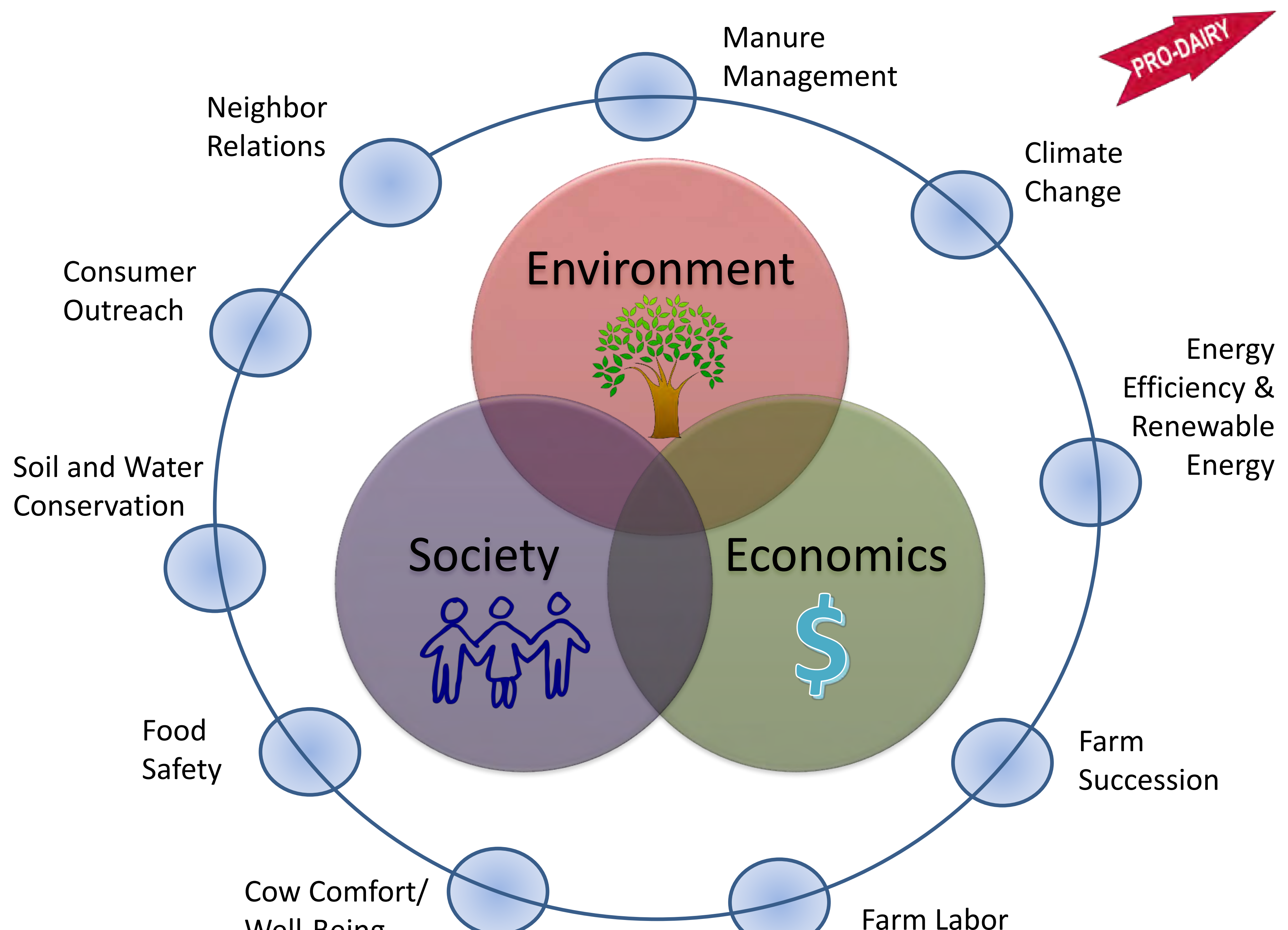
PRO-DAIRY



Source: Pronto, 2016

Presentation Outline

- Brief overview of farm-based AD
- What constitutes a successful anaerobic digestion system?
- AD case studies and lessons learned

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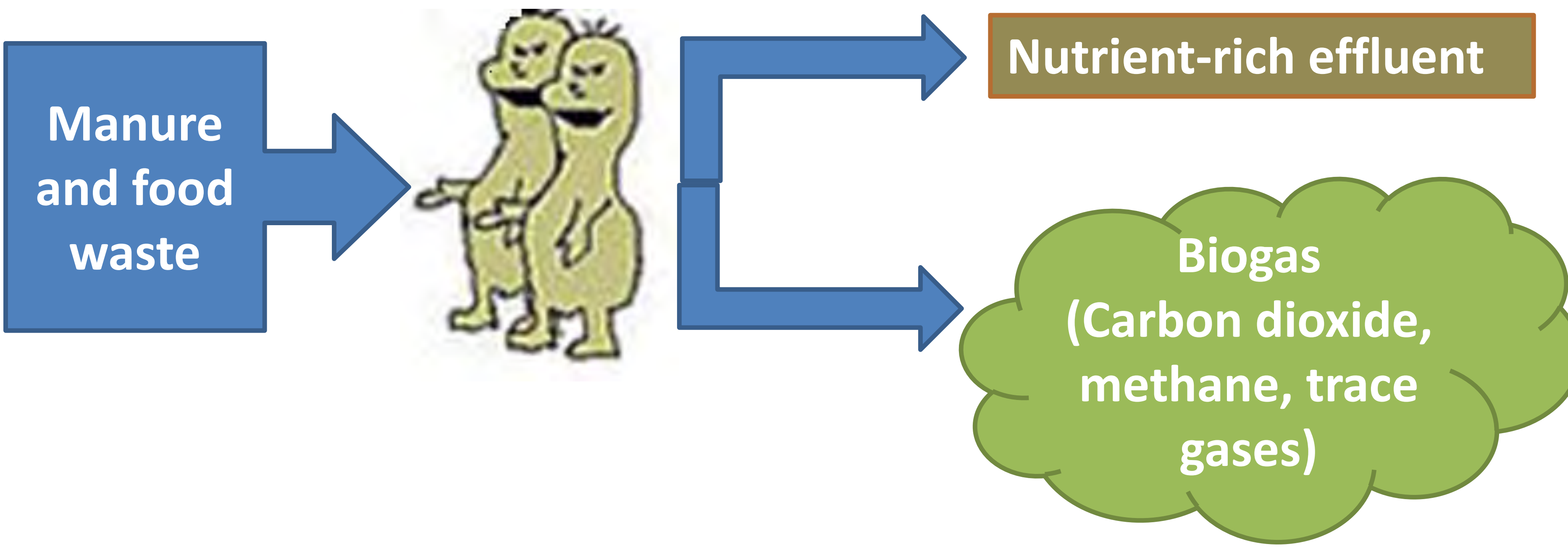
Dairy Manure 101

Dairy Cow Manure:

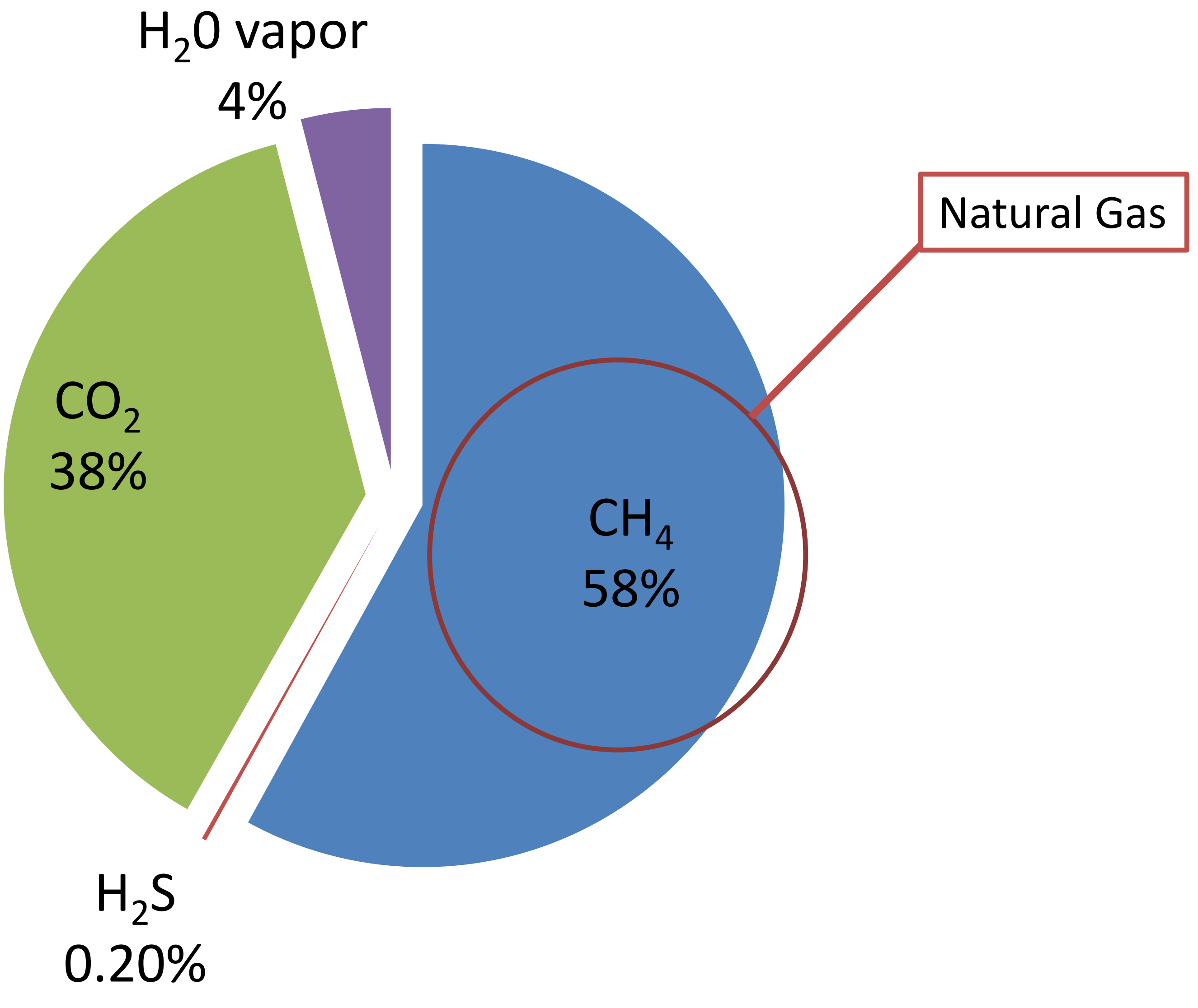
- Total Mass = 150 lbs./cow-day
- Water = 130 lbs.
- Solids = 20 lbs.
- Volatile Solids = 17 lbs.
  - Digestibility = 32% VS
  - With co-digestion, digestibility substantially increases
- Nitrogen = 1 lb.
- Phosphorus = 0.2 lbs.
- Potassium = 0.2 lbs.

Anaerobic Digestion

A *controlled* process, that takes place in the absents of oxygen, where multiple microbe species, work together, to convert organic matter (manure solids) into biogas.



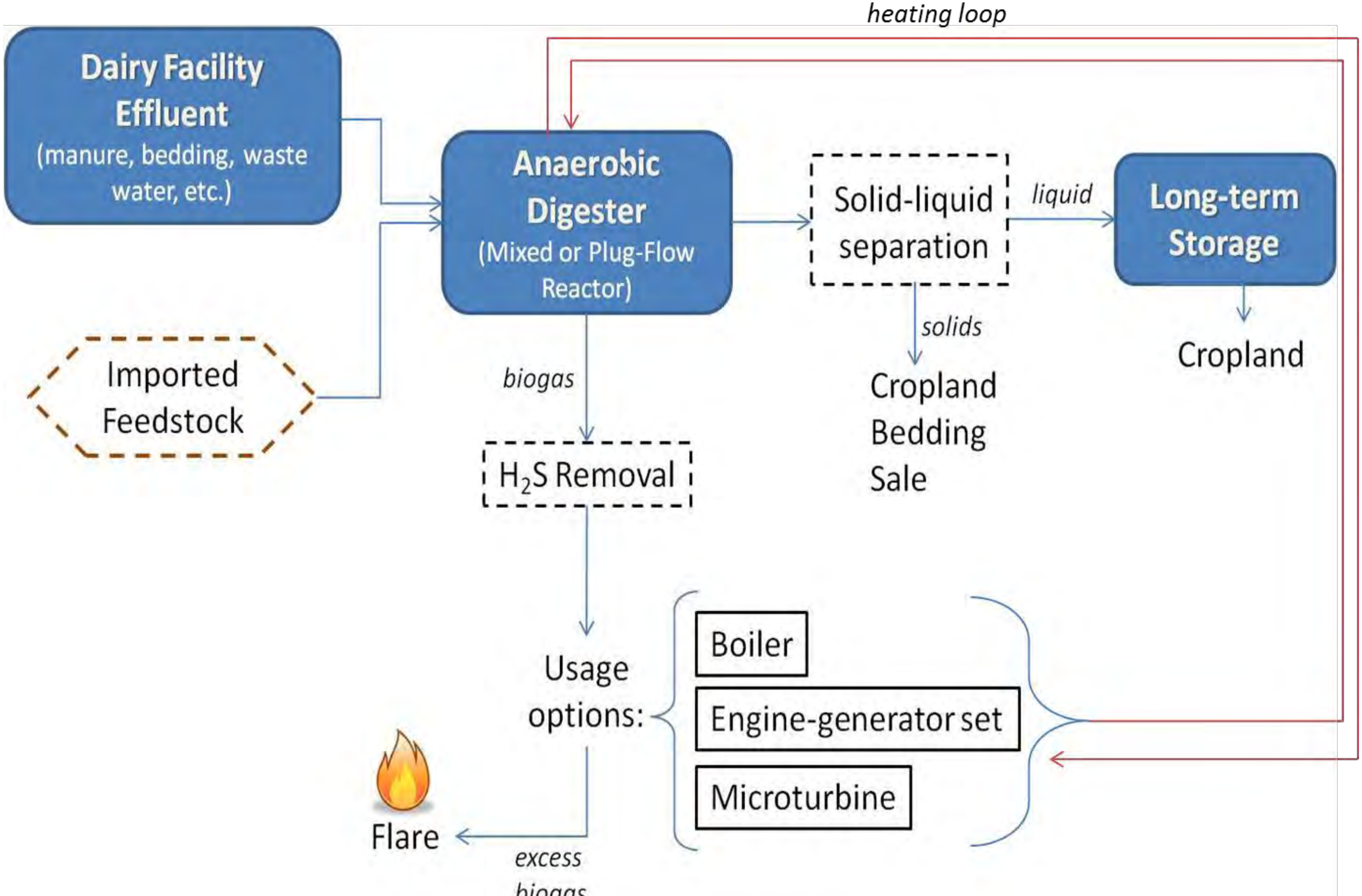
Biogas Composition



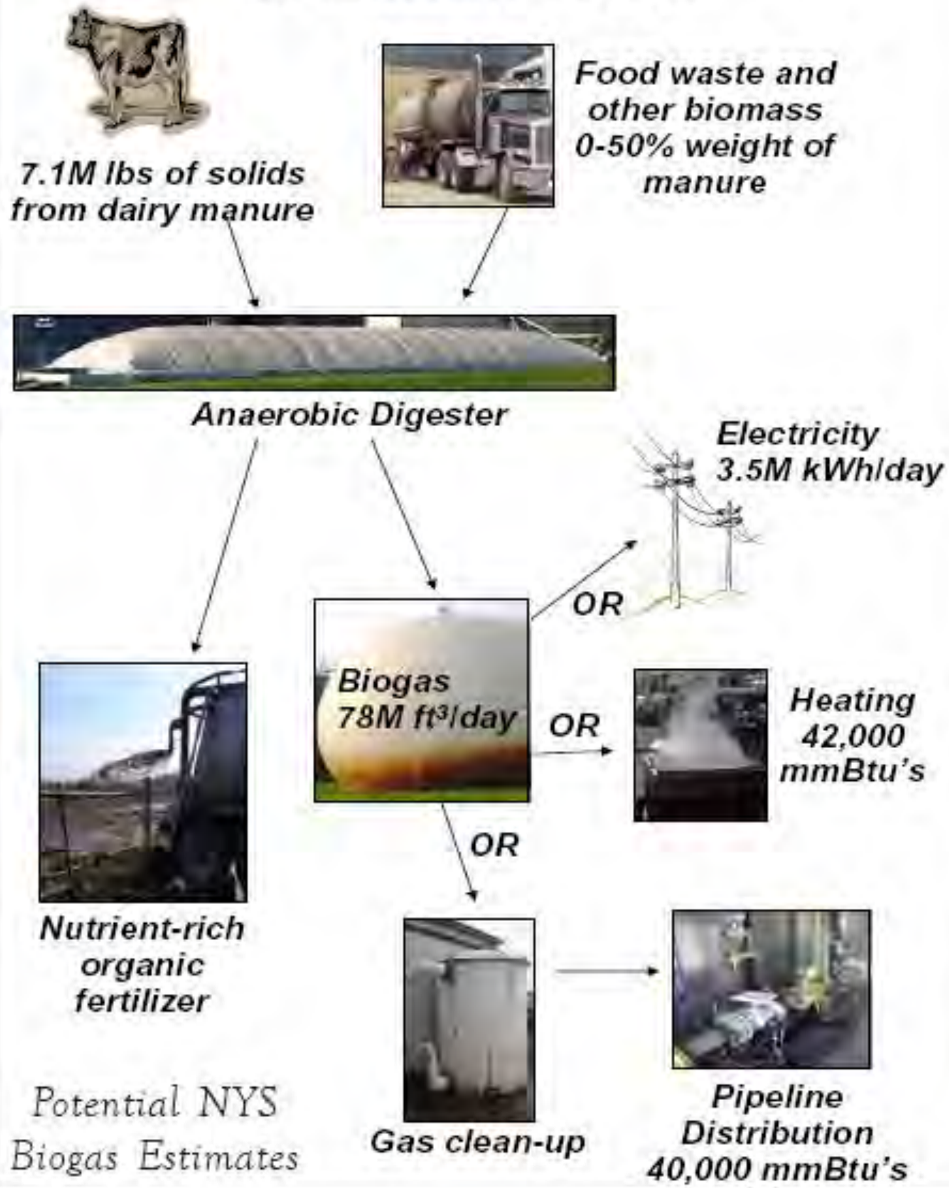
Anaerobic Digester

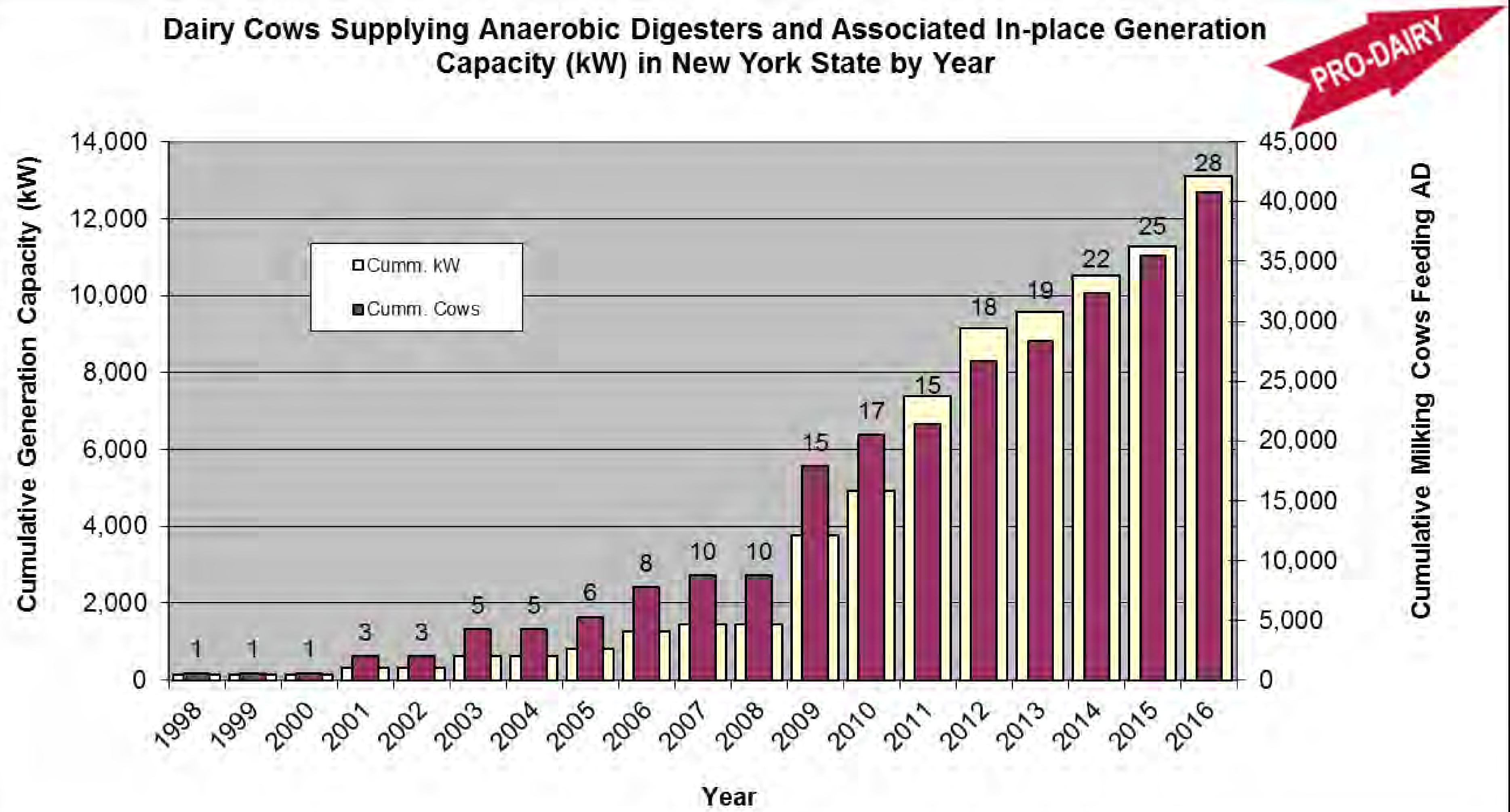
The liquid tight, gas tight vessel in which anaerobic digestion occurs.

Anaerobic Digestion Based Manure Treatment



On-Farm AD: Linking Agriculture, Community and Industry toward a Sustainable Future





Dairy Cows Supplying Anaerobic Digesters and Associated In-place Generation Capacity (kW) in New York State by Year
PRO-DAIRY
Cumulative Generation Capacity (kW)
Cumulative Milking Cows Feeding AD
Cumm. kW
Cumm. Cows
Year
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
1998
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2014
2015
2016
1
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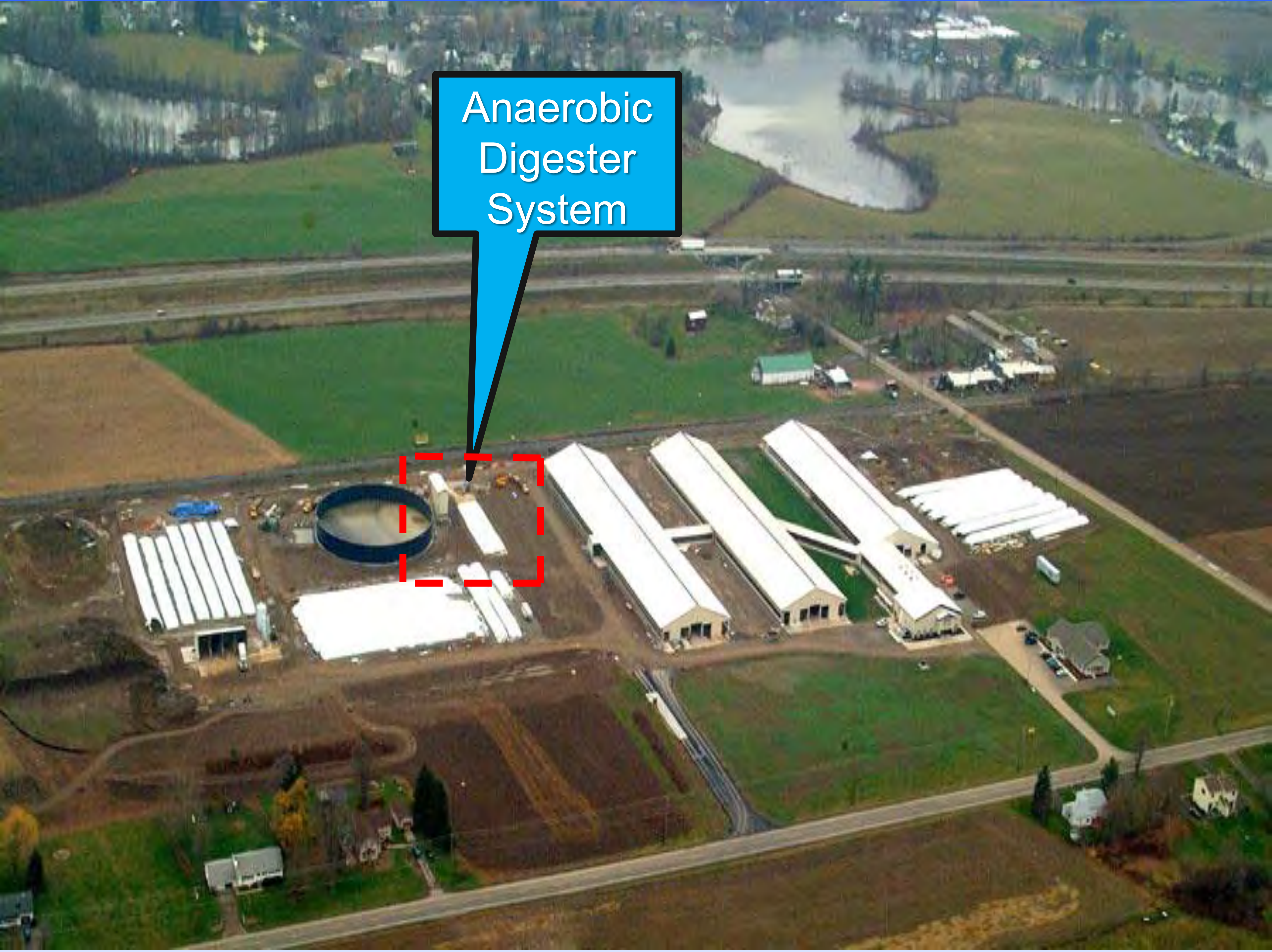
25
28

What is a Successful Digester System?

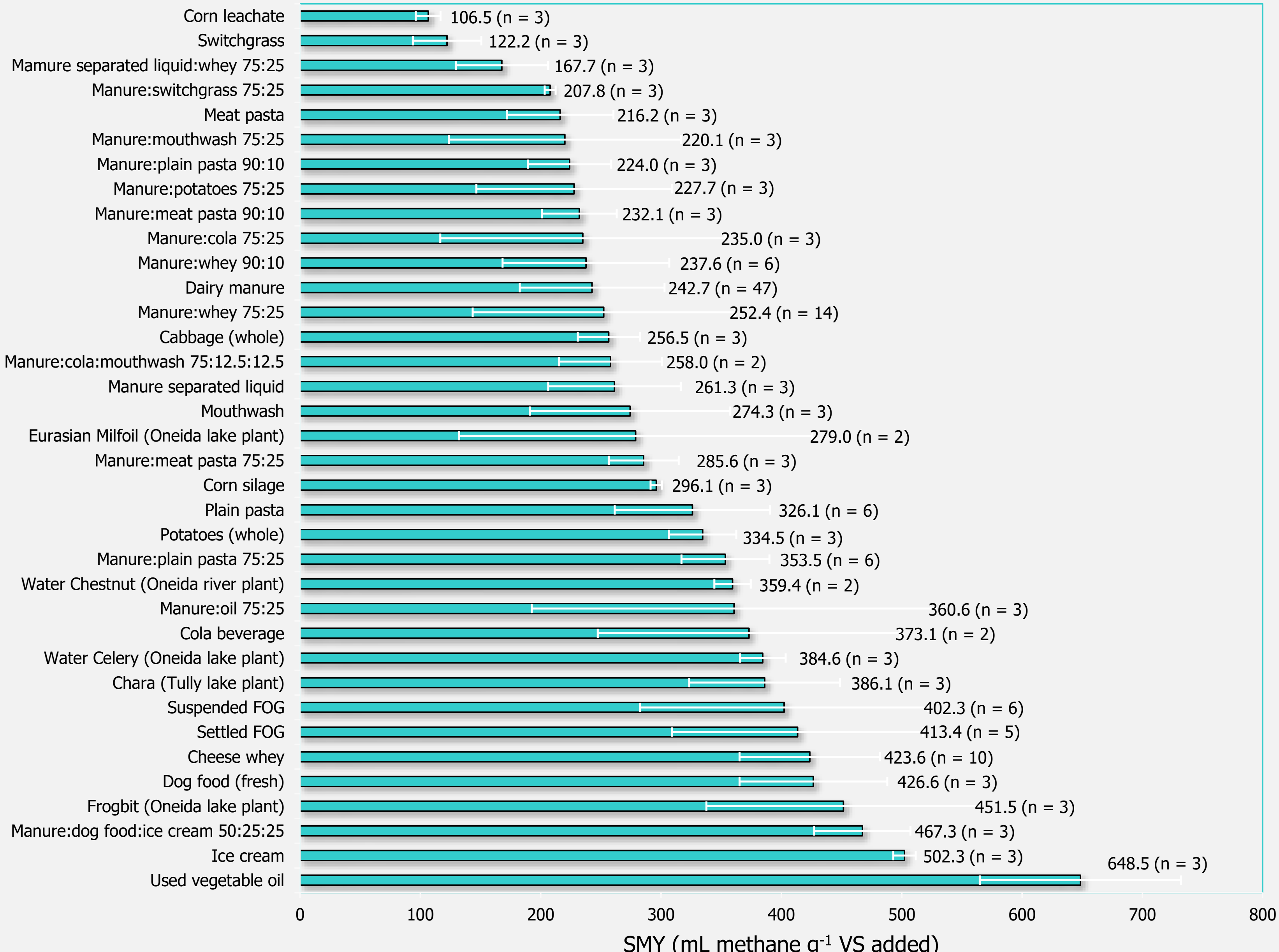

Anaerobic
Digester
System

What is a Successful Digester System?

A: Benchmarks:

- Consistent solid to biogas conversion
  - Manure only - >32% VS to biogas
  - Co-digestion - higher than manure only

Potential Biogas Yields



Source: Labatut et al., 2010

What is a Successful Digester System?

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- Biogas utilization
  - Eng-gen sets - Capacity factor (0.93 or above)

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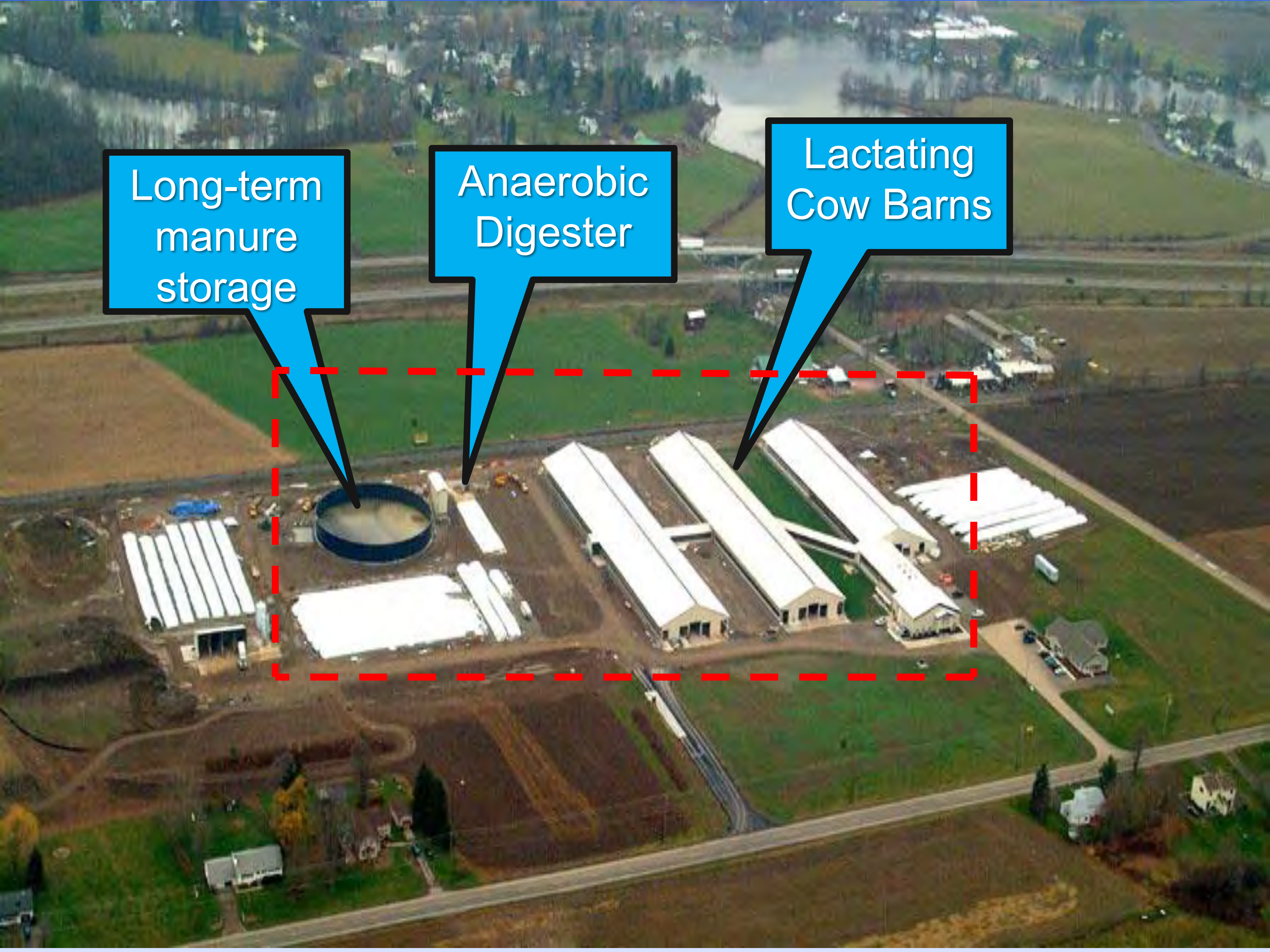
- Economics
  - Annual revenue + displaced cost > annual cost of owning and operating AD system

Take Home Point

- At the present time…if the cost of renewable energy is cheaper than fossil fuel energy, we would not be meeting today (at lease about this topic!).


Long-term manure storage
Anaerobic Digester
Lactating Cow Barns

What is a Successful Manure Treatment System?

A: Benchmarks:

- Greenhouse gas reduction
  - Based on biogas production → destruction
  - Monetized value depends on base condition

Current 28 NYS Operating AD Systems…

- GHG reduction potential of 120,000 $MTC0_2e$
- GHG reduction sufficient to remove 25,500 cars from the highway annually
- Some off-farm organic matter imported for co-digestion increasing GHG reductions and renewable energy generation

What is a Successful Manure Treatment System?

A: Benchmarks:

- Greenhouse gas reduction
  - Based on biogas production → destruction
  - Monetized value depends on base condition
- Recovery of manure solids for bedding
  - Success in using recycled manure solids for bedding


Cropland

What is a Successful Manure Treatment System?

A: Measure:

- Increase pumpability
  - Digested manure easier to pump long distances over raw manure
  - Decreased cost
  - Reduced farm truck traffic

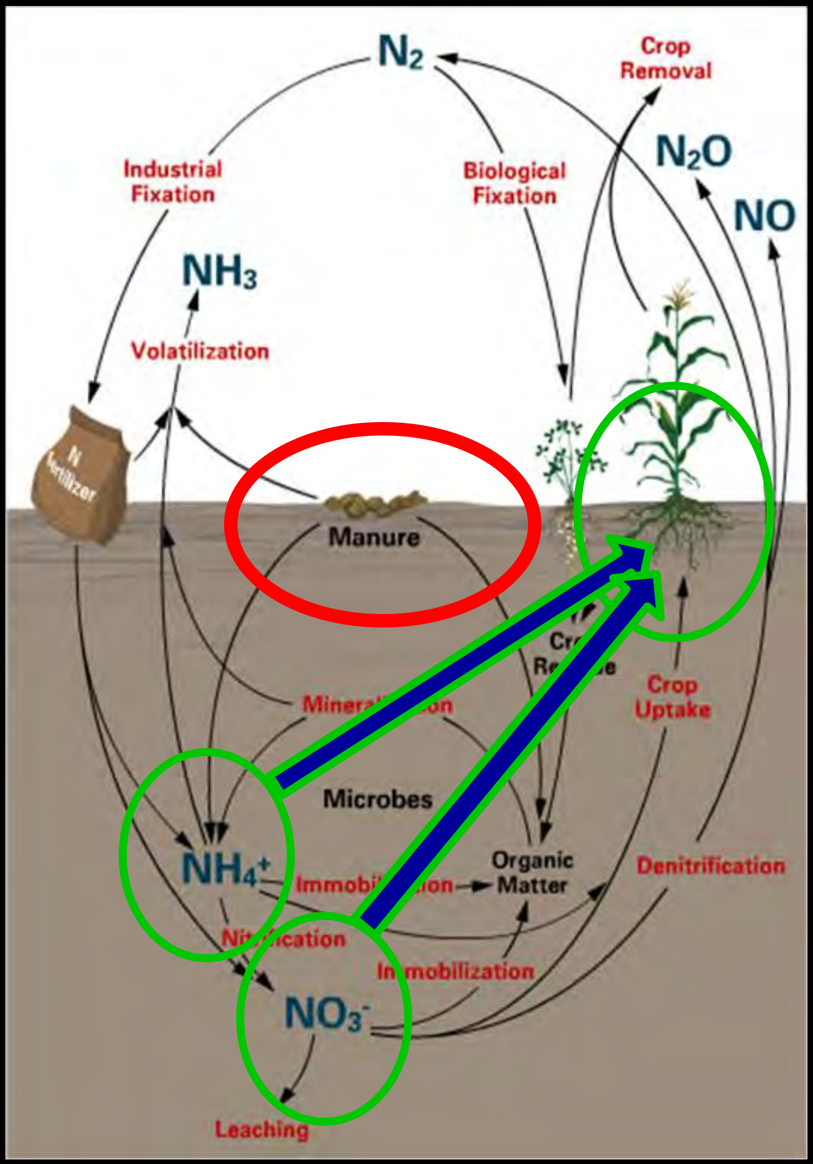
What is a Successful Manure Treatment System?

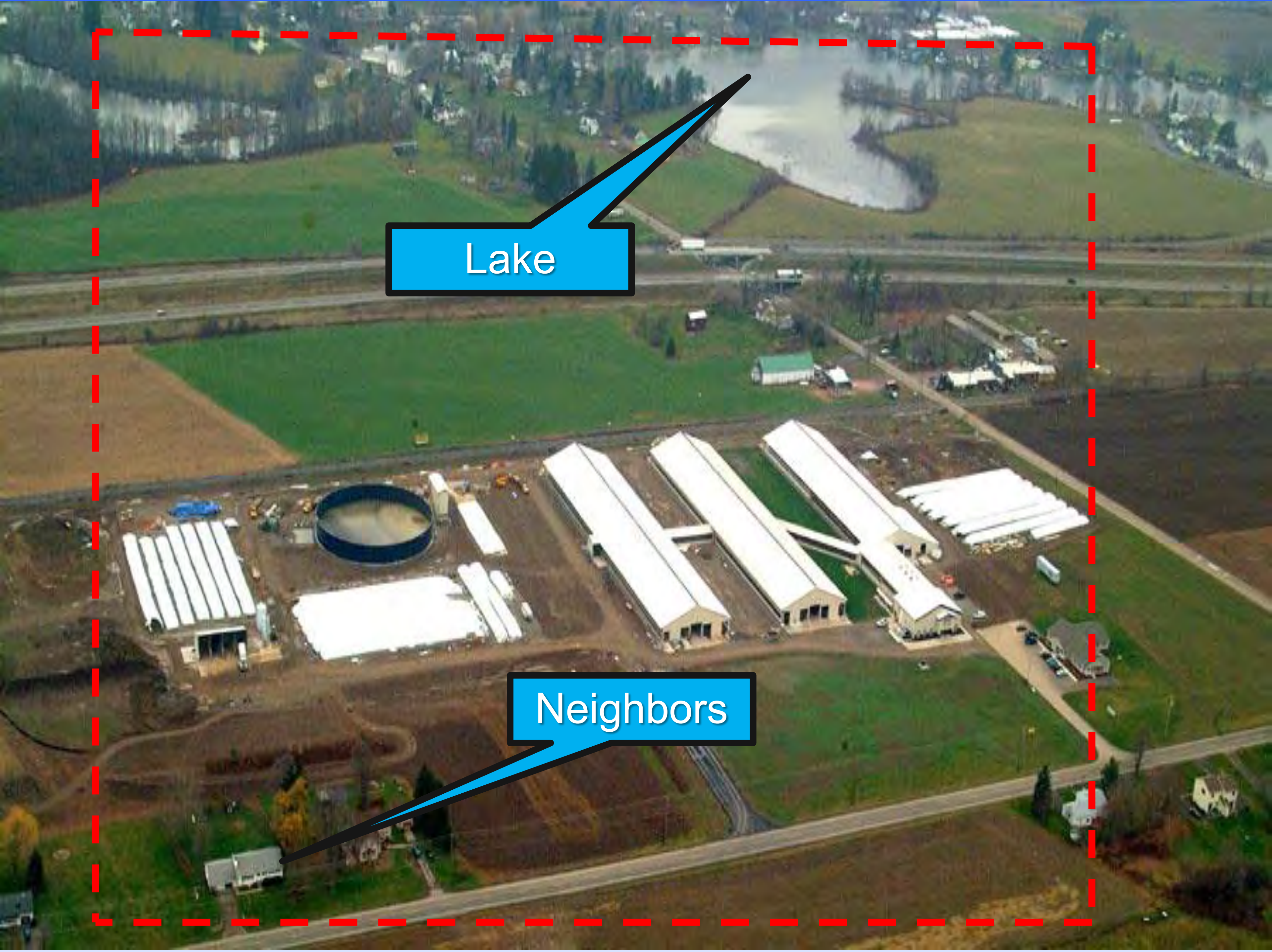
A: Measure:

- Increase pumpability
  - Digested manure easier to pump long distances over raw manure
  - Decreased cost
  - Reduced farm truck traffic
- Increase crop nutrient utilization
  - Digested manure nutrients more plant available than raw manure

Benefits of Aerobic Digestion:

Nutrient Recycling/Utilization




Lake
Neighbors

What is a Successful Manure Treatment System?

A: Measure:

- Reduce odor emissions
  - Happy neighbors!!!
- Reduce farm truck traffic
  - Happy neighbors!!!
- Water quality protection
  - Clean water
  - Happy neighbors!!!

Farm-based Anaerobic Digestion

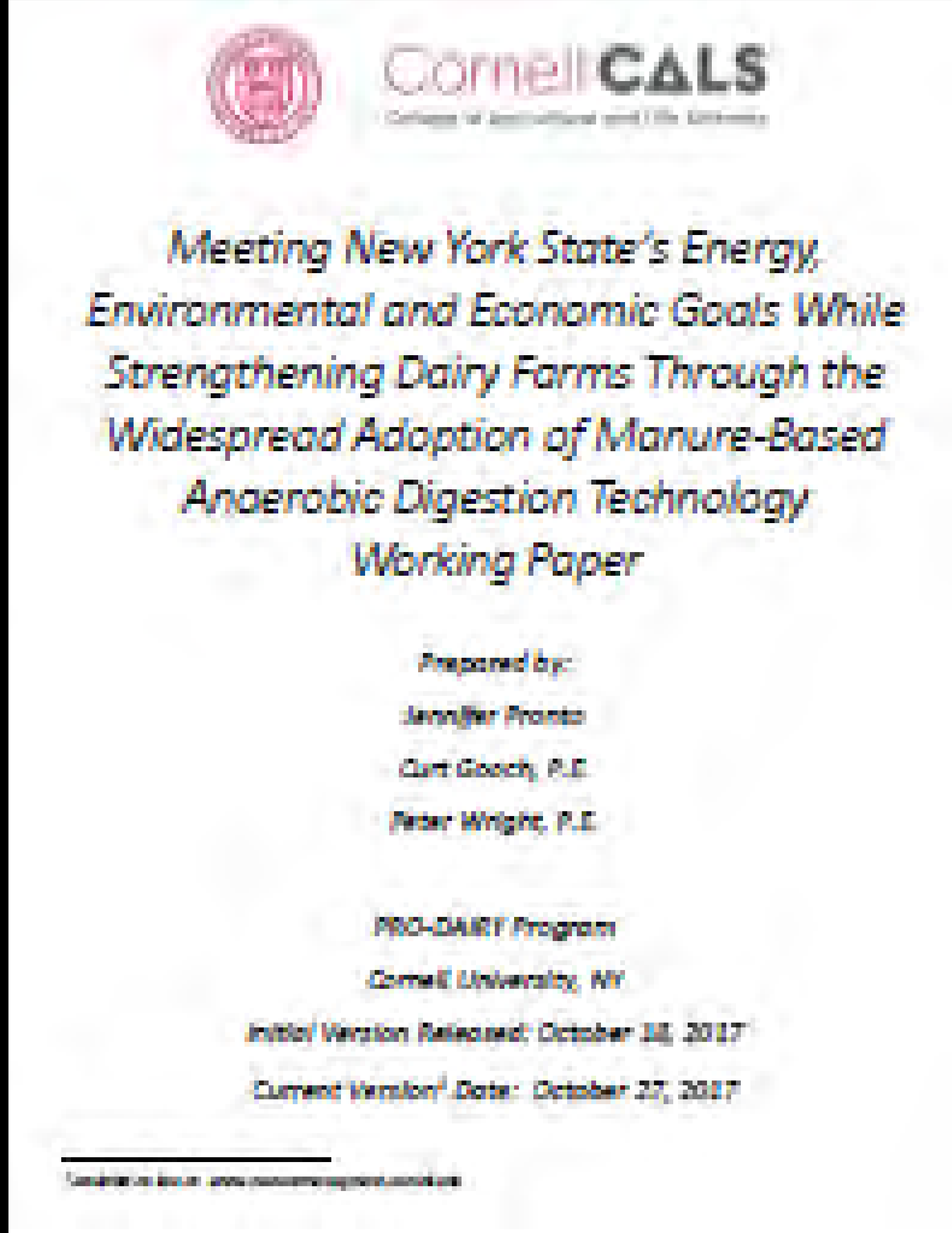
	Directly Monetizable	Society Expectation
• Odor Control	n	Y
• Pathogen Reduction	n	Y
• Renewable Energy Gen	y	y
• Greenhouse Gas Reduction	y	Y
• Water Quality Protection	n	Y
• Fertilizer for Field Crops	n/y	dc
• Low Cost Manure Application	v	dc
• Nutrient Conc./Exportation	p	dc

Take Home Point

- Dairy-derived biogas is the only renewable energy that touches deep into other key basic human needs and has multiple benefits to the environment.

Take Home Point

- Despite all of the benefits anaerobic digestion provides to farms and society, adoption has not been wide spread due to economic challenges.


Cornell CALS

Meeting New York State's Energy, Environmental and Economic Goals While Strengthening Dairy Farms Through the Widespread Adoption of Manure-Based Anaerobic Digestion Technology
Working Paper

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PRO-DAIRY Program

Cornell University, NY

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https://prodairy.cals.cornell.edu/

STATE OF NEW YORK

7742

IN SENATE

February 14, 2018

Introduced by Sens. HELMING, RITCHIE, GRIFFO, FUNKE -- (at request of the Legislative Commission on Rural Resources) -- read twice and ordered printed, and when printed to be committed to the Committee on Energy and Telecommunications

AN ACT to amend the public service law, in relation to setting the rate of credit per kilowatt hour for farm waste generating equipment customer-generators, which includes the anaerobic digestion of agricultural waste

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

Section 1. Legislative Intent. It is the intent of this Legislature to support the ongoing financial viability of farm waste generating equipment customer-generators--more commonly known as anaerobic digesters--in New York state. Anaerobic digesters located on New York dairy farms create critical environmental attributes including, but not limited to, reducing methane gas releases and abating nutrient contamination of nearby water sources. The Legislature also recognizes that legacy anaerobic digesters are not financially viable under the current compensation methodology; as such, legacy anaerobic digesters are at risk of closure. Any closures would undo the significant financial investment made by the state of New York to install anaerobic digesters under the Clean Energy Fund program. Closures would also put New York behind on meeting greenhouse gas emission reduction goals as set forth under the State Energy Plan, and behind on developing a clean, distributed grid. While the New York state Public Service Commission has initiated a proceeding to transition to a compensation methodology based on the value of distributed energy resources, the implementation of the new methodology will not address the immediate financial need of existing, or legacy, anaerobic digesters, or new digesters installed prior to the finalization of a meaningful value stack methodology that includes environmental values attributed to the avoided use of electricity generated by fossil fuels and the reduction of on-site greenhouse gas emissions.

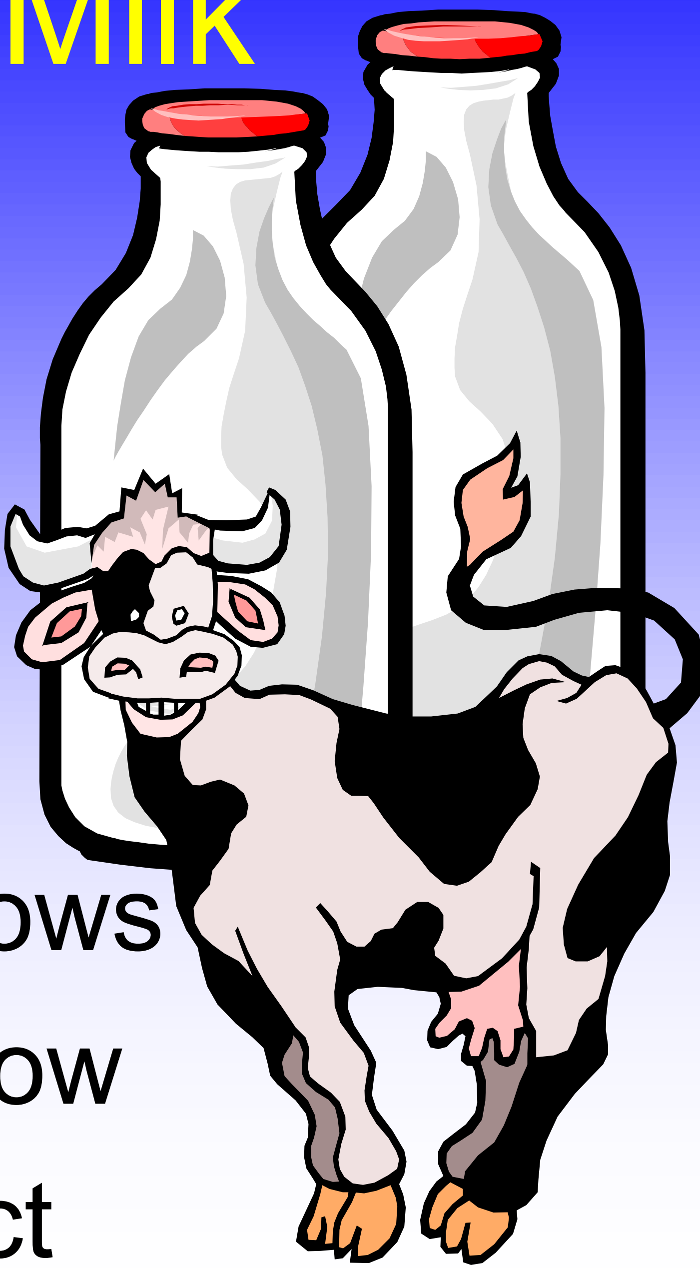
The Legislature hereby determines that the public interest requires an increase in the rate of compensation for customer-generators operating

EXPLANATION--Matter in *italics* (underscored) is new; matter in brackets [ ] is old law to be omitted.

LBD13738-03-8

Consumers Want Milk That Is:

- Affordable
- High quality
- Safe
- Produced by healthy cows
- From farms that have low environmental impact



Presentation Outline

- ✓ What constitutes a successful anaerobic digestion system?
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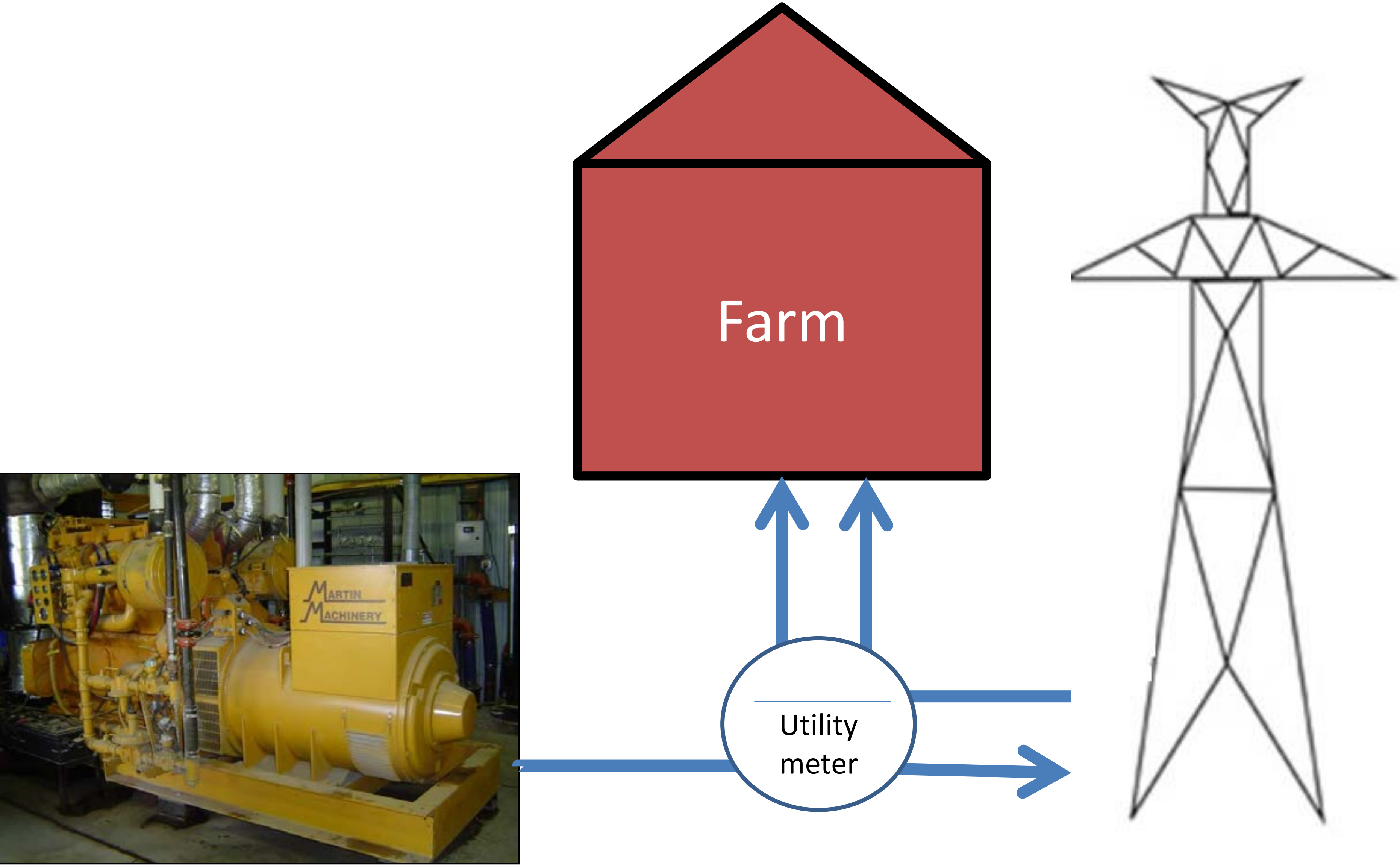
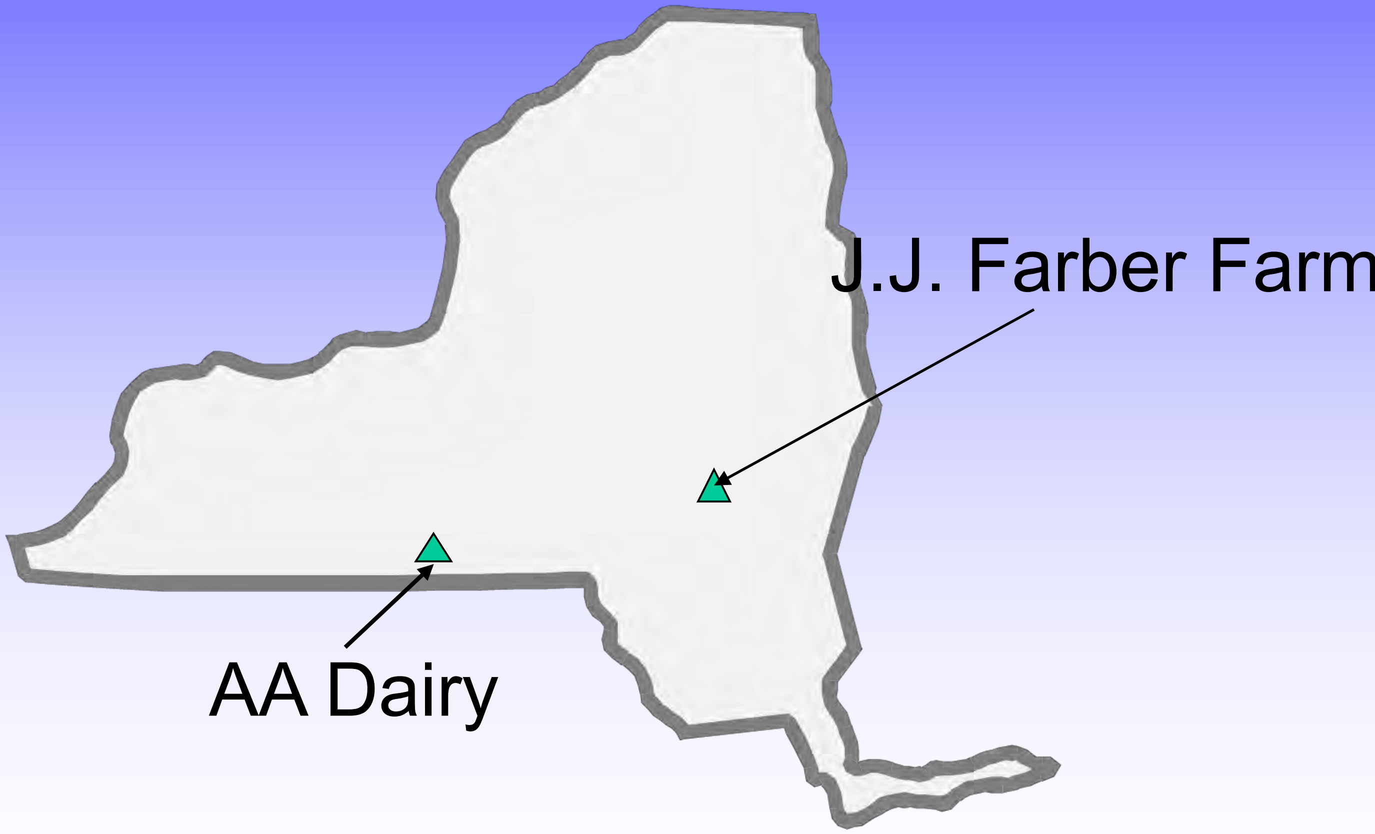
1998 – AA Dairy

AA Dairy – Key Lessons and Outcome…

NYS Net Metering Law



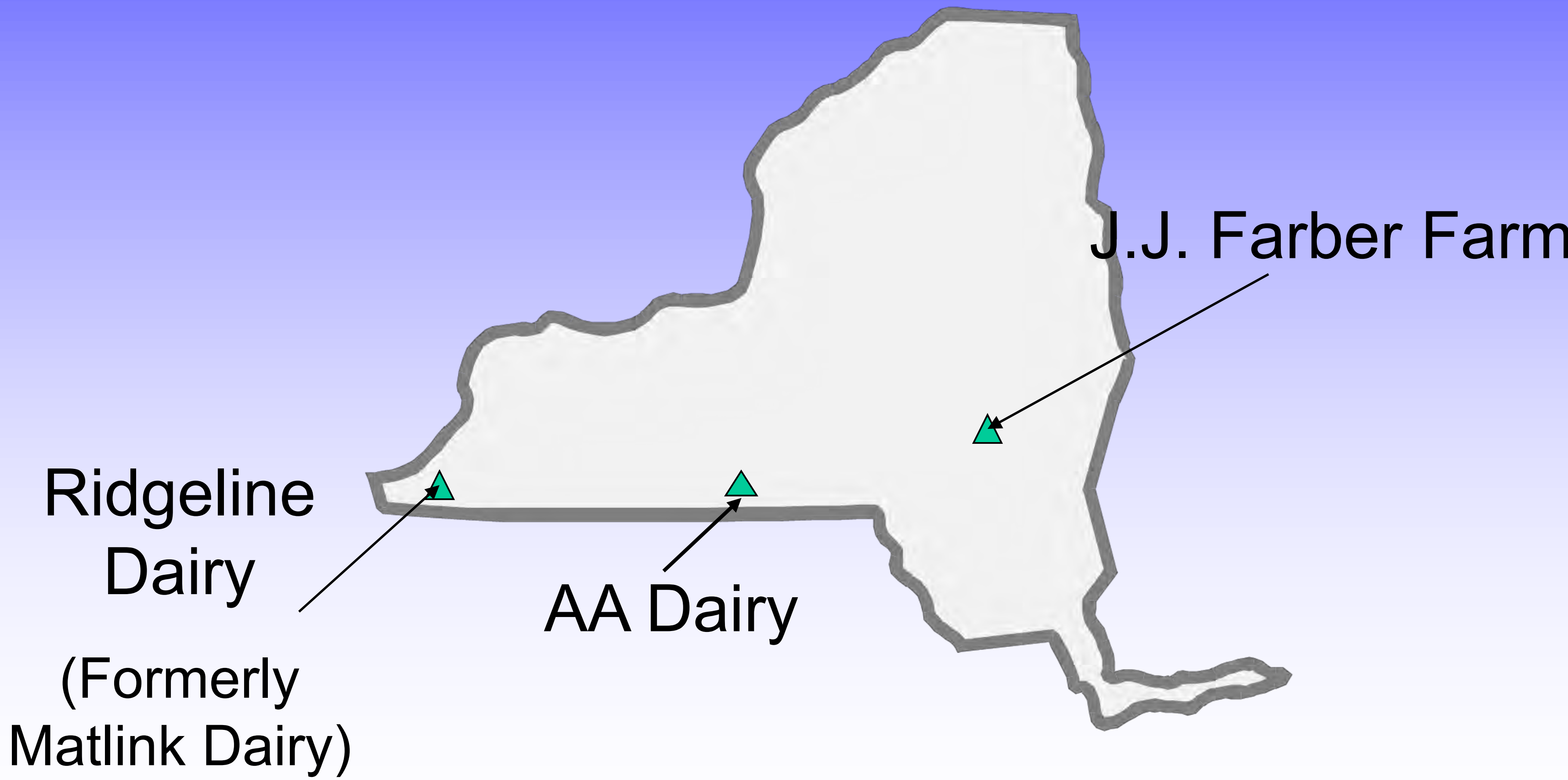
2000 – J.J. Farber Farm



J.J. Farber Farm Anaerobic Digester – Lessons and Outcomes

Farber Farm Anaerobic Digester

2001 - Matlink Dairy



Matlink Dairy – Key Lessons and Outcome…

Total Annual Economic Cost or Economic Benefit

Total Annual Cost – Total Annual Benefit

Table 4. Estimated net income or loss for the five digester systems.

	Farm				
	AA	DDI	NH	ML	FA
Number of Cows	[illegible]	850	1,100	740	100
Capital Costs					
Digester Set	[illegible]	[illegible]*[4]	$339,400	$298,149	$80,183
Separator Set	[illegible]	[illegible]	$61,000	$61,689	$44,013
Gas Utilization Equipment	[illegible]	[illegible]	$287,300	$130,431	$13,135
Total Capital Cost	[illegible]	[illegible]	[illegible]	$490,269	$137,331
Total Capital Cost Per Cow	$606	[illegible]	[illegible]	$663	$1,373
Annual Projected Capital Cost	$25,468	[illegible]	[illegible]	$49,016	$13,396
Annual Projected Capital Cost Per Cow	$51	[illegible]	[illegible]	[illegible]	$134
Total Estimated Annual Cost*[1]	$37,540	$79,317	[illegible]	[illegible]	$21,497
Total Estimated Annual Cost Per Cow*[1]	$75	$93	[illegible]	[illegible]	$215
Total Estimated Annual Revenues	$56,445	$60,400*[3]	$77,680	[illegible]	[illegible]
Total Estimated Annual Revenues Per Cow	$113	$71*[3]	$71	[illegible]	[illegible]
Total Estimated Annual Cost or Benefit*[1] *[2]	$18,906	-$18,917 *[2] *[3]	-$26,280*[2]	[illegible]	[illegible]
Total Estimated Annual Benefit Per Cow*[1] *[2]	$38	-$22*[2] *[3]	-$24*[2]	$293	-$106*[2]

*[1] Does not include system electrical use.
*[2] Negative numbers mean the farm incurs a net loss from the digester system.
*[3] The electrical savings for DDI assumes the price of electricity is 10 cents/ Kw. This farm actually incurs a lower cost due to a specific business initiative. Since this is not typical of most dairy farms, the higher price is used.
*[4] This cost assumes the microturbines were purchased new.

-$38/cow

$22/cow

$24/cow

-$293/cow

$106/cow

Source: Gooch and Inglis, 2006

Noblehurst Farms and Affiliates

Noblehurst Green Energy

Noblehurst Green Energy

- One of the newest anaerobic digesters in NYS
  - Completed Fall 2014, interconnected April 7, 2015
- Drivers
  - Business diversification
  - Reducing dairy costs (lower electricity costs over time)
  - Eliminating smell in the manure
  - Providing service to on-site milk processing facility
- Goals
  - Self sufficiency – "standing on its own" financially
  - Income diversification (electricity and food waste)
  - Job creation

Noblehurst Green Energy

- 1.33 million gallon EnviTec complete mix digester
- 450 kW Guascor CHP net metered with National Grid
- Wholly owned subsidiary of Noblehurst Farms
  - 1800 cow multi-generation, multi-family dairy farm
  - Farming 3000 acres of corn, alfalfa and triticale
- Co-located with Craigs Station dairy complex
  - Craigs Station Creamery separation facility operational in 2014
  - Craigs Station Cheese facility commissioned February 2018
  - Innovative wastewater pre-treatment by Clear Cove Systems

Current Process

Current Process:

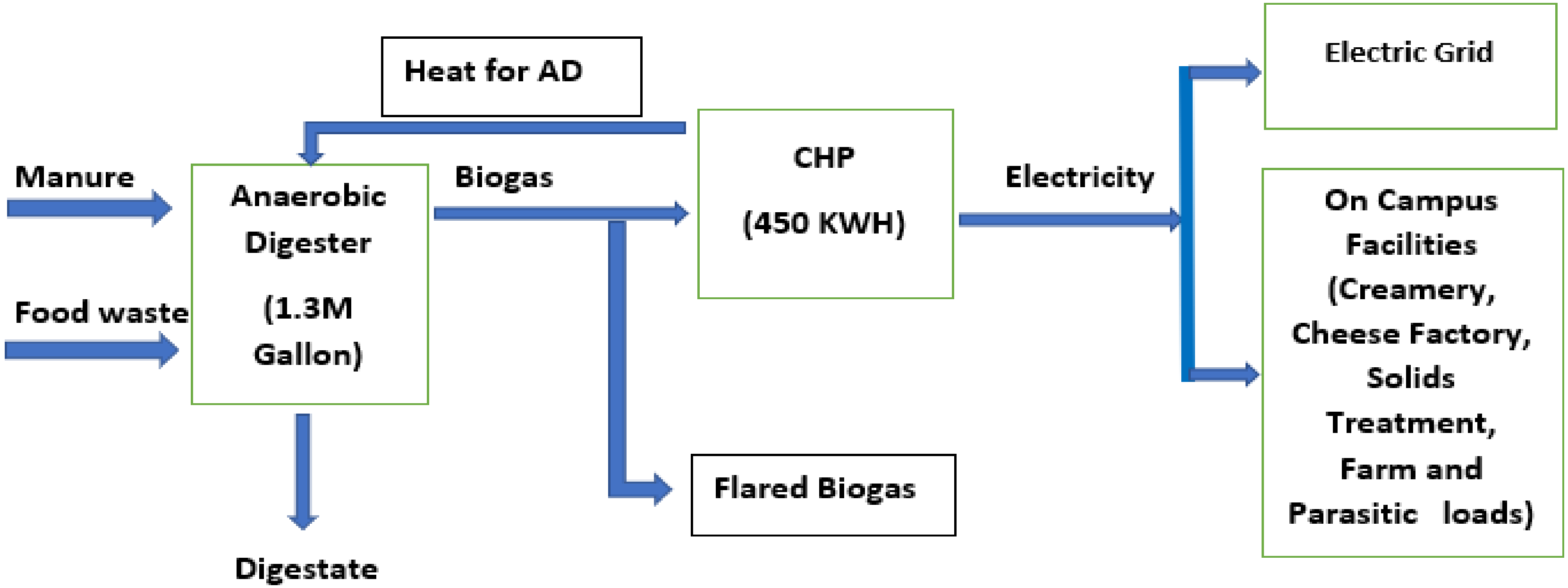


Figure 1: Current Process at NGE

Noblehurst Green Energy

- Current energy production and utilization
  - Approximately 315 SCFM biogas produced
  - Utilizing +/- 150 SCFM through the CHP
  - Flaring another 50-60% of the biogas <u>and not yet optimized</u>
- Electricity production approximately 3,500,000 kWh/year
- Net metered – 70% used on campus
  - 45% Noblehurst Farms (average w/seasonality)
  - 25% Craigs Station Creamery
  - Remaining 30% National Grid and/or Clear Cove (just started)
  - Projected to be neutral production vs consumption by 2019

Noblehurst Green Energy

- Current feedstocks
  - **Manure** from 1800 dairy cows at Noblehurst Farms
  - Committed high-strength **dairy processing waste** direct piped from Craigs Station Cheese facility
  - Additional **acid whey** and high-strength volumes direct piped from Craigs Station Creamery
  - **Source separated organics** – up to 15 tons per day of clean, pre-consumer material delivered by Natural Upcycling
  - **Packaged liquid and semi-solid organics** – processing 20-30 tons per day of juices, soda, syrups, etc. delivered by Natural Upcycling
  - Bulk tanker loads including **condensed whey** from Craigs Station Cheese and customers in the region

Noblehurst Green Energy

- Opportunities – “Challenging” Feedstock

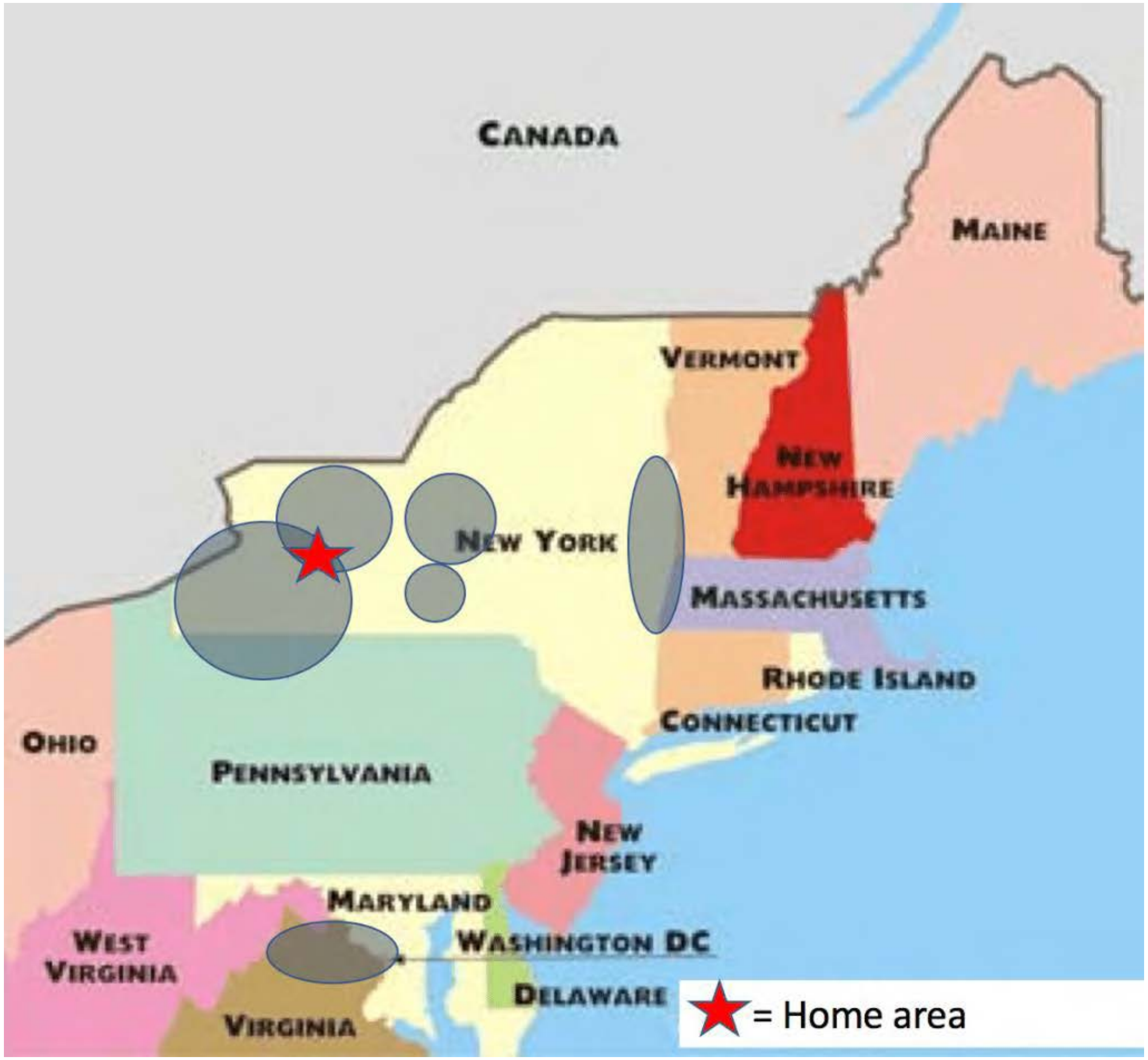
Noblehurst Green Energy

- Challenges
  - Logistics: from customer to disposal site
  - Contamination: wanted control over the feedstock quality
  - Variety: all food waste isn’t created equal
  - Episodic: especially on packaged food waste
- Solution

NaturalUpcycling

CREATING A SUSTAINABLE FUTURE FOR OUR COMMUNITY

Where we are – SSO collection



What Can Be Upcycled?

Organics Pickup Service

- Participating businesses place food waste in color-coded bins located in kitchens or food prep areas.
- Once bins are loaded, they are wheeled to a back dock or other convenient location to be picked up.
- These bins are serviced up to 5 days per week by a specialty vehicle and cleaned by a high pressure system all contained within the truck.
- Sanitized containers limit odor and provide a sterile work environment.

Packaged Food Waste

- Developed strategic relationships with disposal sites that can cost-effectively accommodate these substrates
- Sites in New York, Pennsylvania and Connecticut

Noblehurst Green Energy, NY

Reinford Farms, PA

What We Do Well

- Align with companies that are leaders in sustainability
- Reduce methane gas emissions & create renewable energy
- Communicate with our partners and customers
- Share the message of keeping food waste out of landfills
- Core value of doing the right thing

Sample Customers

gimme! coffee

Wegmans

ROCHESTER INSTITUTE OF TECHNOLOGY R·I·T 1829

WhiteWave FOODS

CHIPOTLE MEXICAN GRILL

HOBART AND WILLIAM SMITH COLLEGES

RICH'S ®

Got Manure?

Enhancing Environmental & Economic Sustainability Conference

Anaerobic Digestion: The ***Cornerstone*** *of an* *<u>Integrated</u>* *Manure Treatment System*

Curt Gooch, P.E.

Dairy Housing and Waste Management Engineer

Biological and Environmental Engineering

Cornell University

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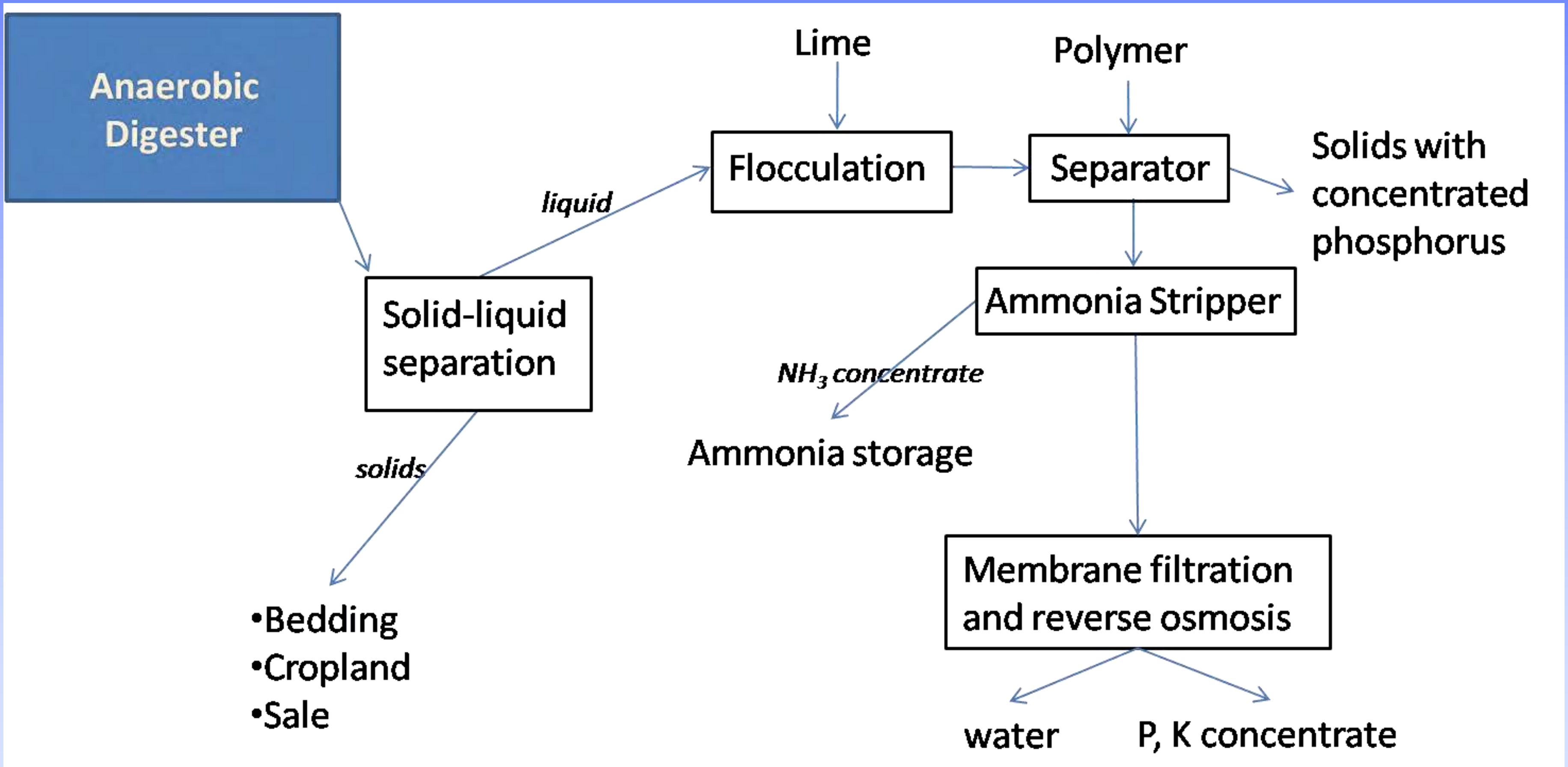
PRO-DAIRY

Advanced Post-Digestion Treatment System Process Flow Diagram



Source: D. Kirk, MSU


PARKSON

Ammonia-N Stripping