Technical Education and Analysis for Community Hauling and Anaerobic Digesters

(TEACH AD)

TEACH AD Webinar Series - May 31, 2022

Universities go green! A case study from the Michigan State University South Campus Anaerobic Digester

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Technical Education and Analysis for Community Hauling and Anaerobic Digesters – TEACH AD

The goal of this program is to help communities and water resource recovery facilities in the Midwest region divert food waste from landfills by providing education and no-cost technical assistance to explore the increased adoption of anaerobic digestion and renewable energy biogas technologies.

- Educational Assistance
- Technical Assistance

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PROGRAM OFFERINGS

Technical Assessments	In-person Workshops
On-line Webinars	Project profiles

ELIGIBLE FACILITIES AND PROJECTS

Water Resource Recovery Facilities	Municipal Food Waste Digesters
Community - Based Digesters	Food Processing, On-Farm Digesters

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Webinar Speakers

Marcello Pibiri

Senior Research Engineer

UIC Energy Resources Center

Dana M. Kirk, Ph.D., P.E.

Associate Professor

Michigan State University

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Thanks to our sponsor!

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EPA United States Environmental Protection Agency

Q&A

Submit your questions to the host using the Q&A box in the upper right-hand corner

Presentations

A recording of today’s webinar will be posted on the TEACH AD webpage and you will be emailed a link by early next week

Survey

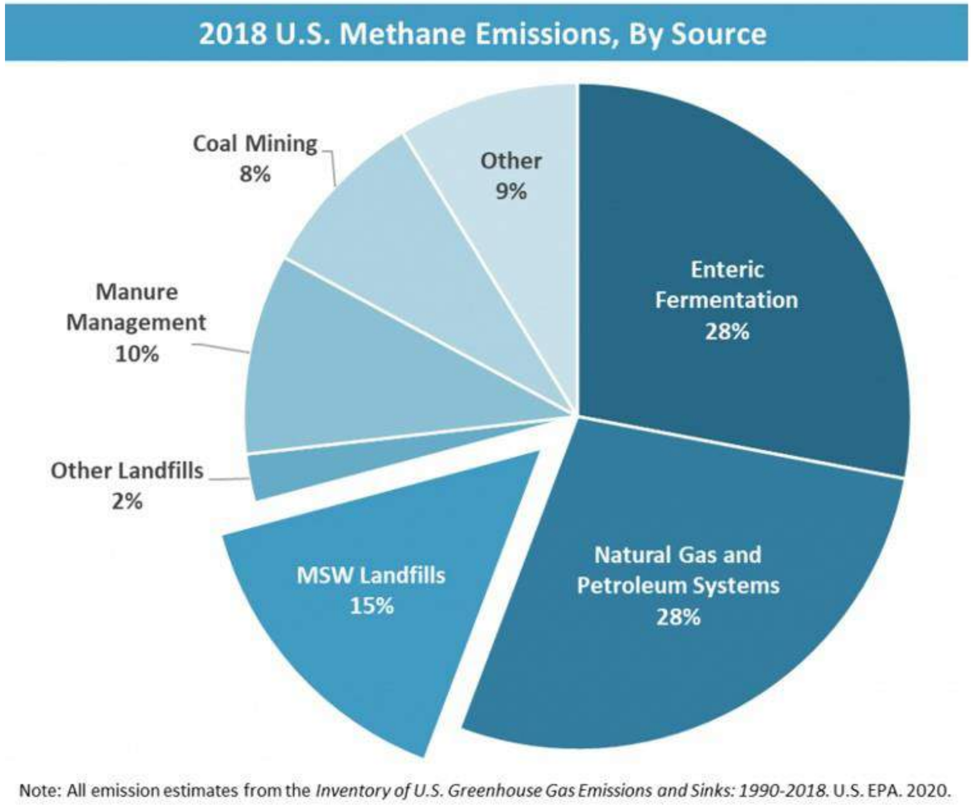
After the presentation you will receive a brief survey. We appreciate your feedback

Technical Issues

Contact Sam Rinaldi at: samr@uic.edu or 312-996-2554 for assistance

Importance of diverting food waste from landfills

- Municipal solid waste (MSW) landfills are the third-largest source of human-related methane emissions in the United States
- By reducing the amount of food waste landfilled, we reduce methane emissions



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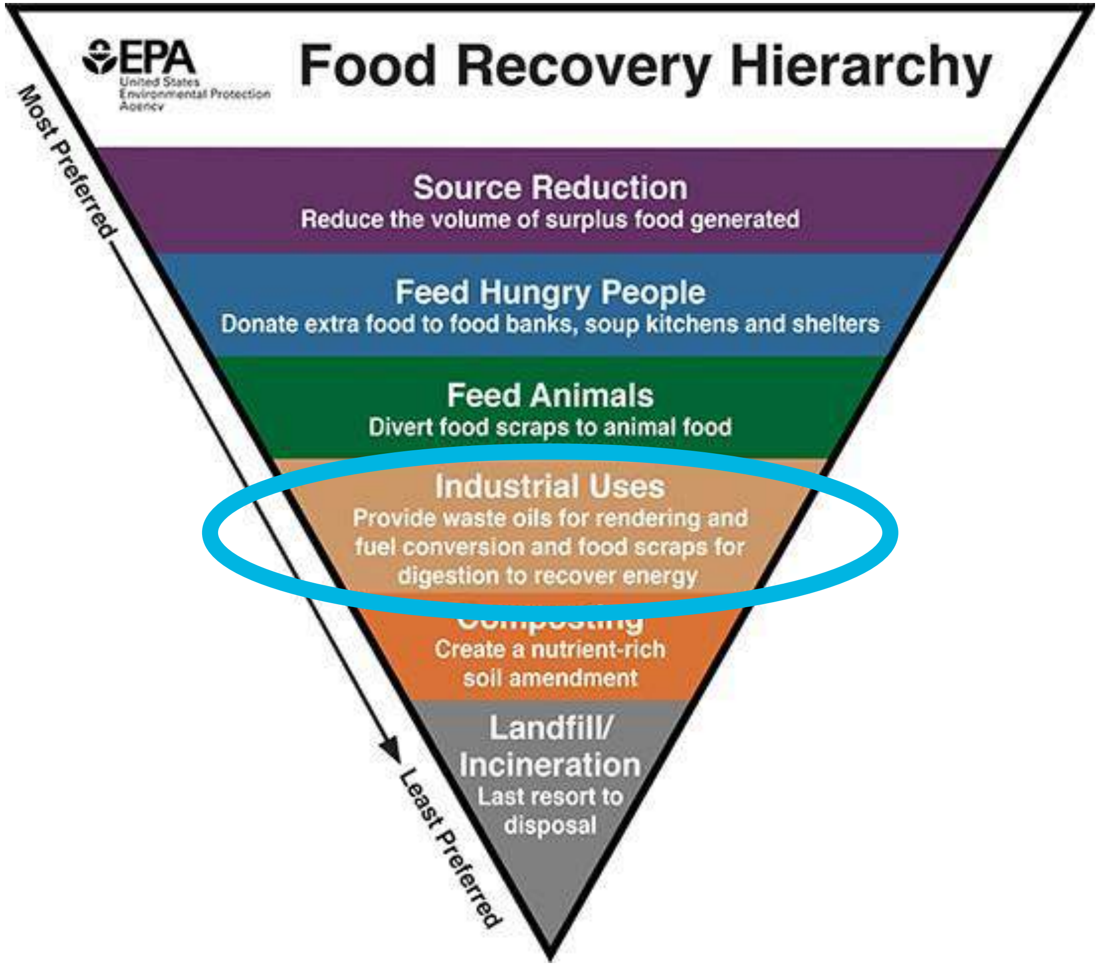
Importance of diverting food waste from landfills

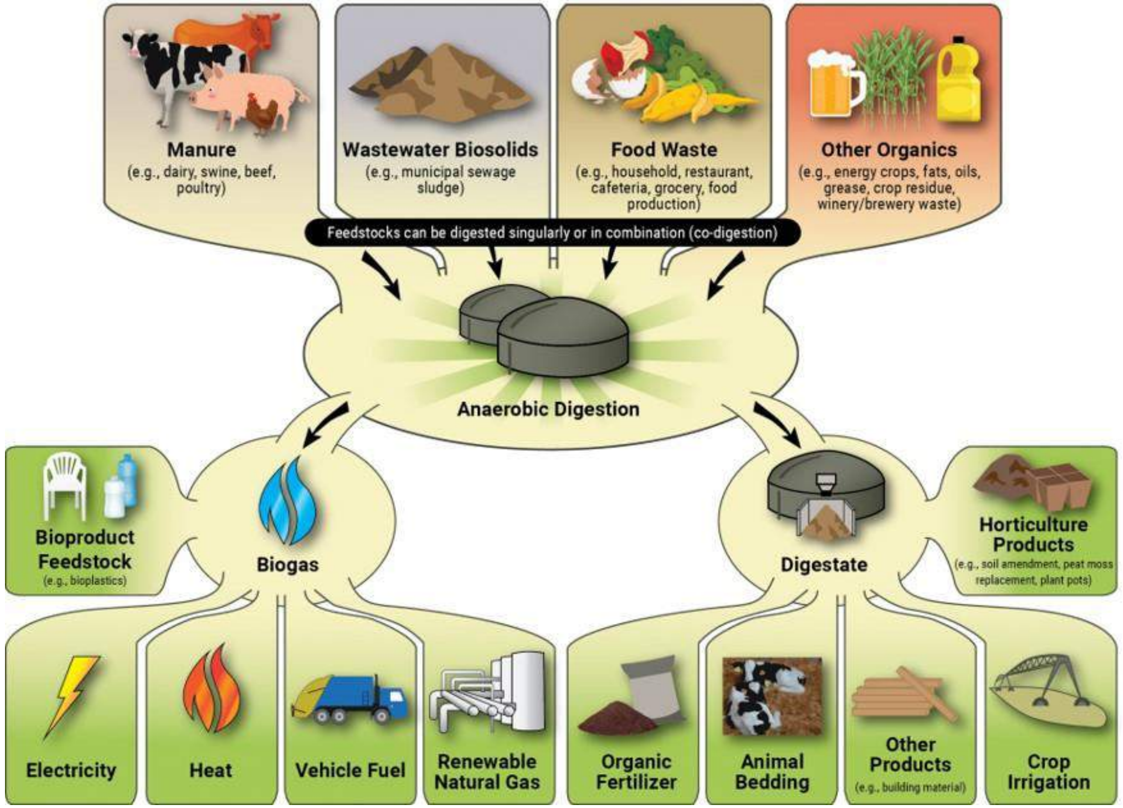
- One-third of all food produced for human consumption worldwide is lost or wasted
- Source Reduction
- Feed People, Not Landfills
- Industrial Uses
    - **Anaerobic digestion**



Overview of anaerobic digesters

- Anaerobic digestion is the natural process in which microorganisms break down organic materials in the absence of oxygen.
- Two valuable outputs
  - Biogas
  - Digestate

Sources: U.S. Environmental Protection Agency



Environmental Impacts of U.S. Food Waste:

What resources go into a year of food loss and waste in the U.S.?

*excluding impacts of waste management, such as landfill methane emissions

Greenhouse gas emissions of more than 42 coal-fired power plants

Enough water and energy to supply more than 50 million homes

The **amount of fertilizer** used in the U.S. to grow all plant-based foods for U.S. human consumption

An **area of agricultural land** equal to California and New York

Learn more: www.epa.gov/land-research/farm-kitchen-environmental-impacts-us-food-waste

https://www.epa.gov/system/files/documents/2022-01/organic_waste_management_january2022.pdf

Michigan State University South Campus Anaerobic Digester

9 years of life lessons

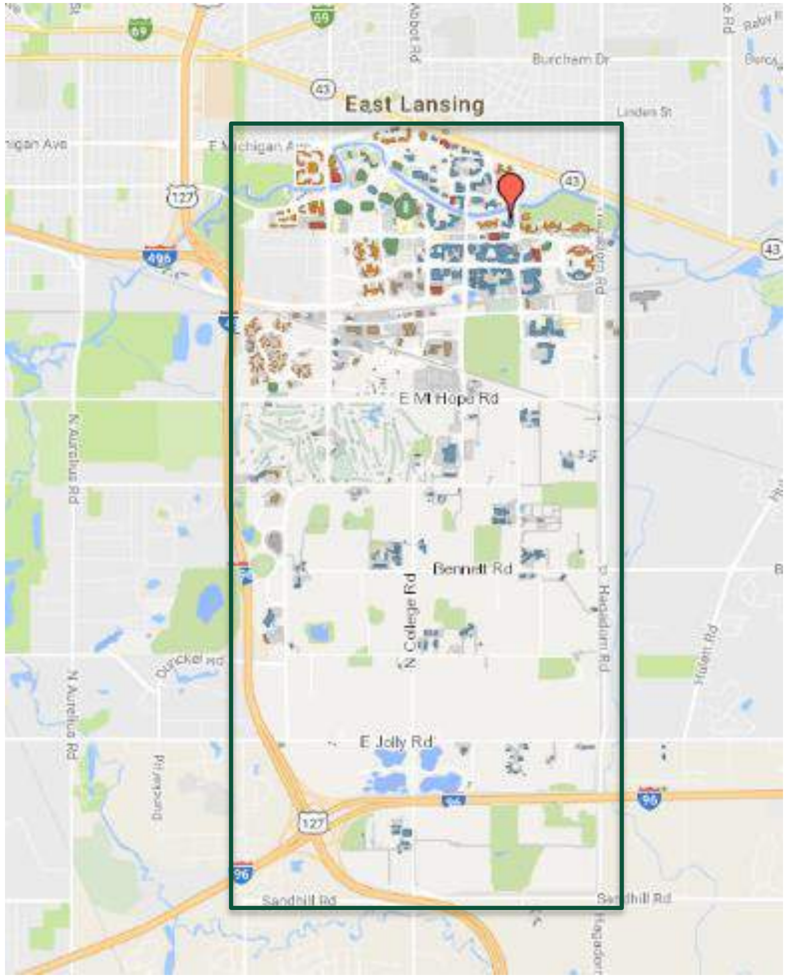
Dana Kirk, Ph.D., P.E., Louis Faivor, & Fahmi Dwilaksono
Michigan State University
Biosystems and Agricultural Engineering Department
Anaerobic Digestion Research and Education Center

MSU by the Numbers

- Size: 5,200 acres

- Student body
  - 51,000 strong
  - All 50 states
  - 138 countries
  - 15% international

- Housing:
  - 28 residence halls
  - 2 apartment complexes
  - 14,000 residences



History of Campus Sustainability

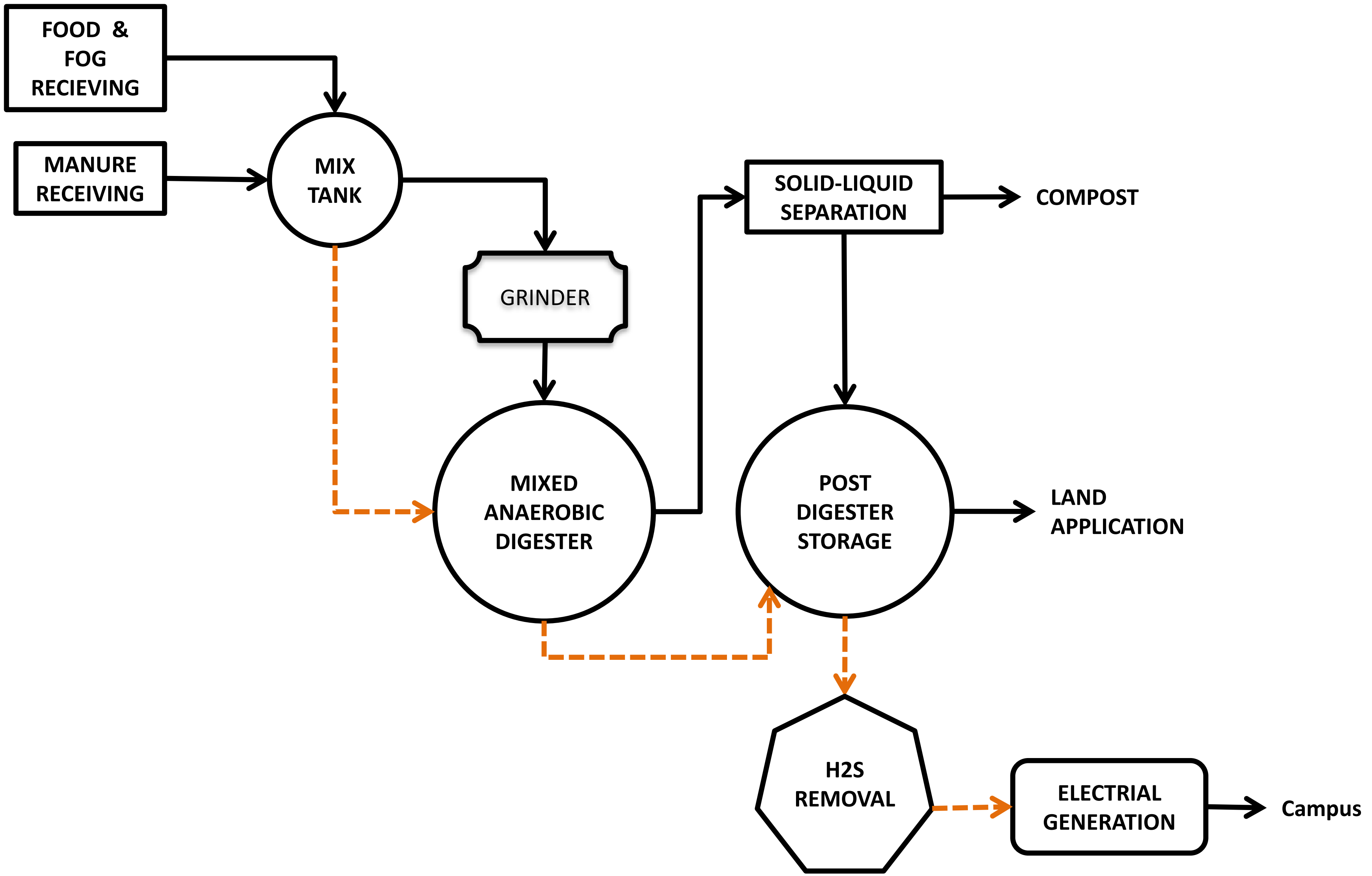
- Recycling (1988)
  - Construction of Recycling Center & Surplus Store (2009)
- Sustainability Plan (2011)
  - Significant recycling efforts, lacked options for organics
  - Campus food waste is approximately 1.80 lb/person/day **(3x US average)**
- Energy Transition Plan (2012)
  - South Campus Anaerobic Digester first project (2012)
  - 2015 renewable energy target of 15%
  - 2015 30% reduction in GHG emissions
  - 2015 end of the “coal era”
  - 2016 20 MW solar array planned
  - 2021 27MW natural gas power plant

South Campus Anaerobic Digester (SCAD)

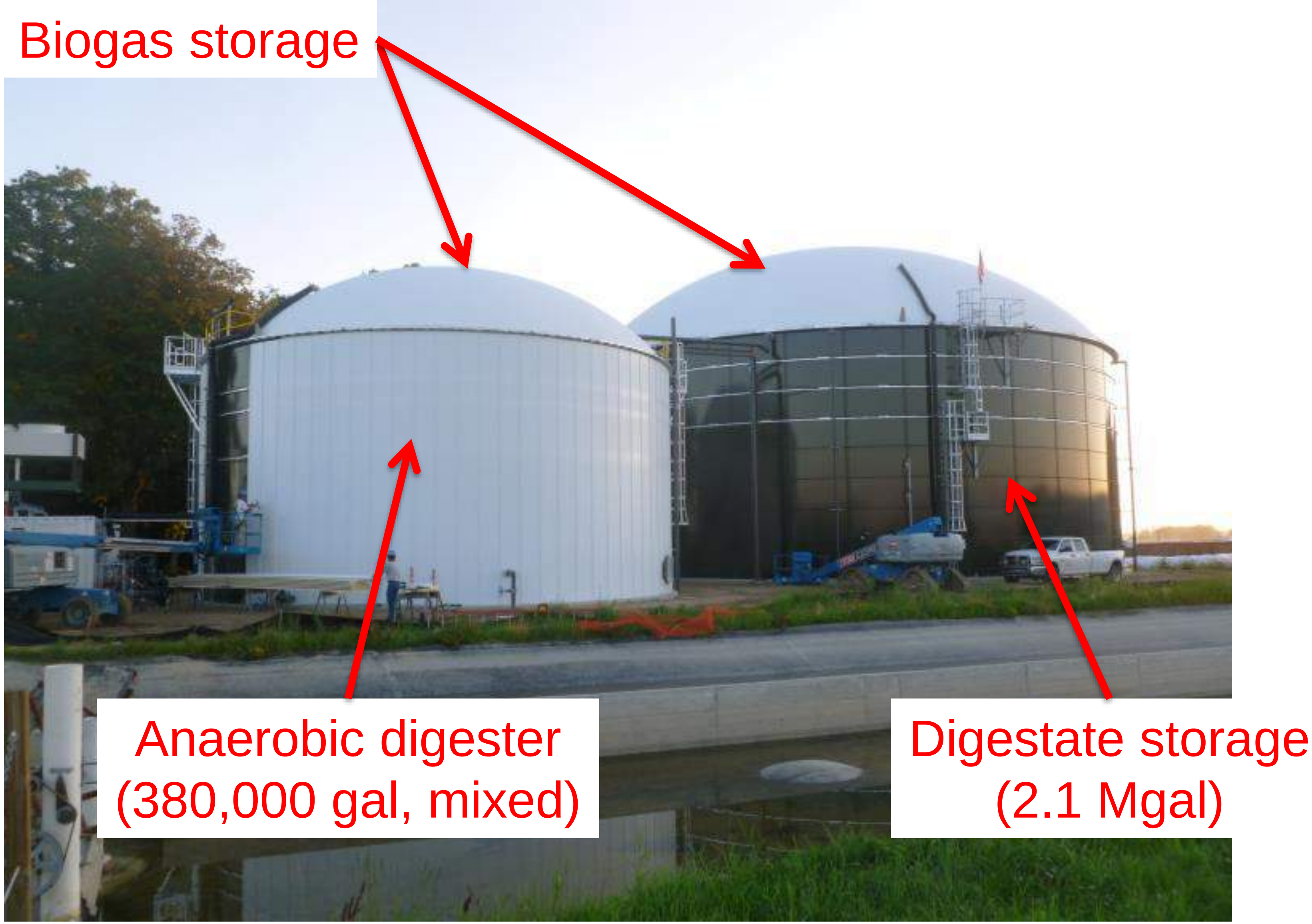
MSU South Campus Anaerobic Digester

- Digester tank
  - 52’ * 26’ plus cover (380,000 gallons)
- Digestate storage tank
  - 101’ * 42’ plus cover (2.1 million gallons)
- CHP system
  - 380 kW electrical production & 400+ kW of thermal energy recovery
  - Electricity supplied to Campus
  - Thermal energy used to sustain the process, heat support building and separator area
- Digestate
  - Separated solids to compost
  - Separated liquid to storage and land application

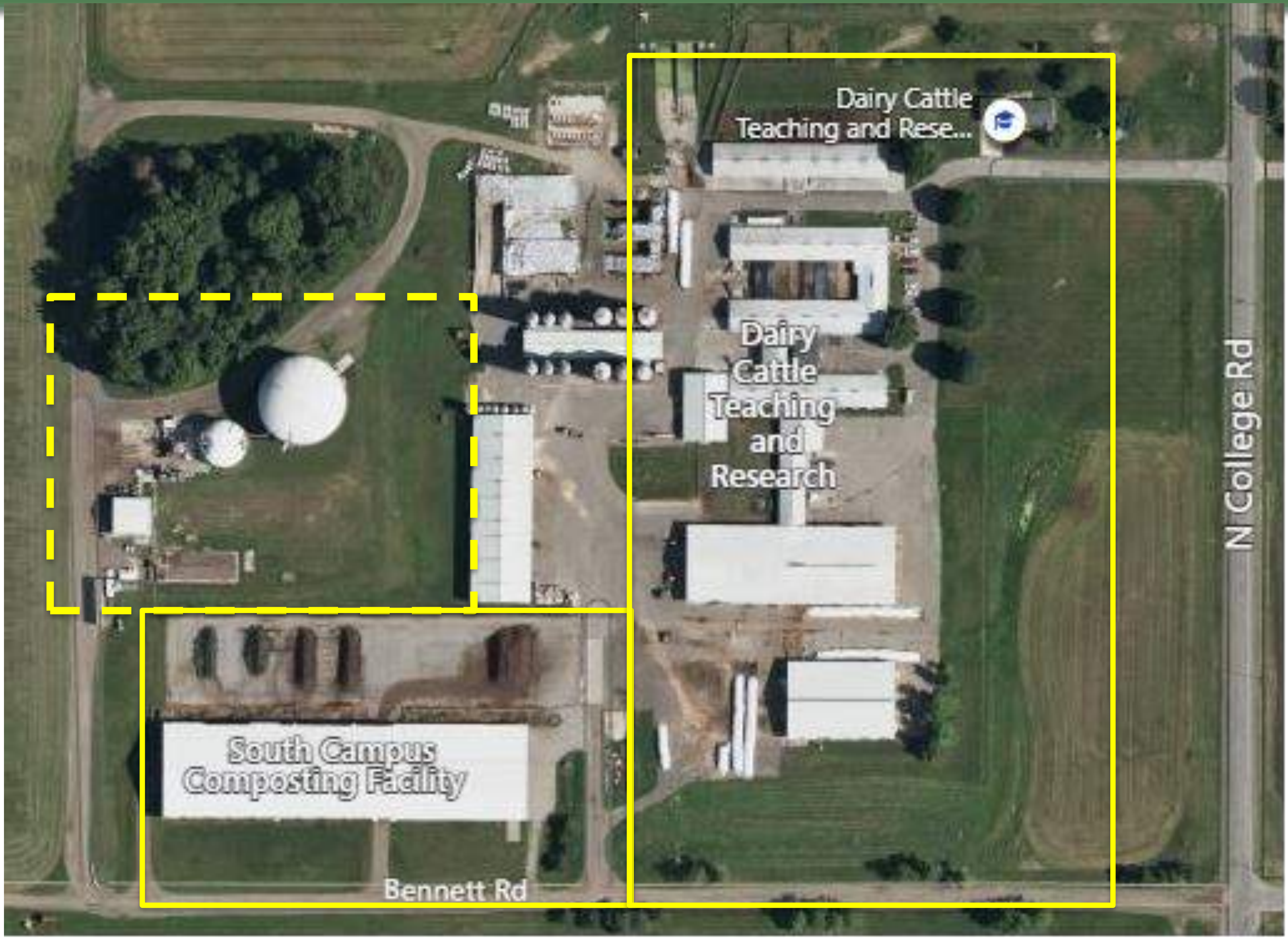
Generalized Process Flow for SCAD



Anaerobic digester & digestate storage



South Campus Anaerobic Digester Site



Bing Maps,. 2021

Key Sources of Organic Waste on Campus

- **University Farms (manure)**
  - Dairy, Swine, Beef, Sheep, Poultry, Equine
  - Pavilion

- **Campus Living (food waste)**
  - Culinary Services serves over 35,000 daily, 150,000+ weekly
  - 9 dining halls have all access from 7AM to 12AM
  - 24 coffee shops/convenience stores/retail foods
  - Hotel & conference centers (2x)

- **Grease interceptors (FOG)**

- **Food processors & manufacturers**

South Campus AD Feedstocks

Feedstock (input) receiving

SCAD Manure Feedstocks

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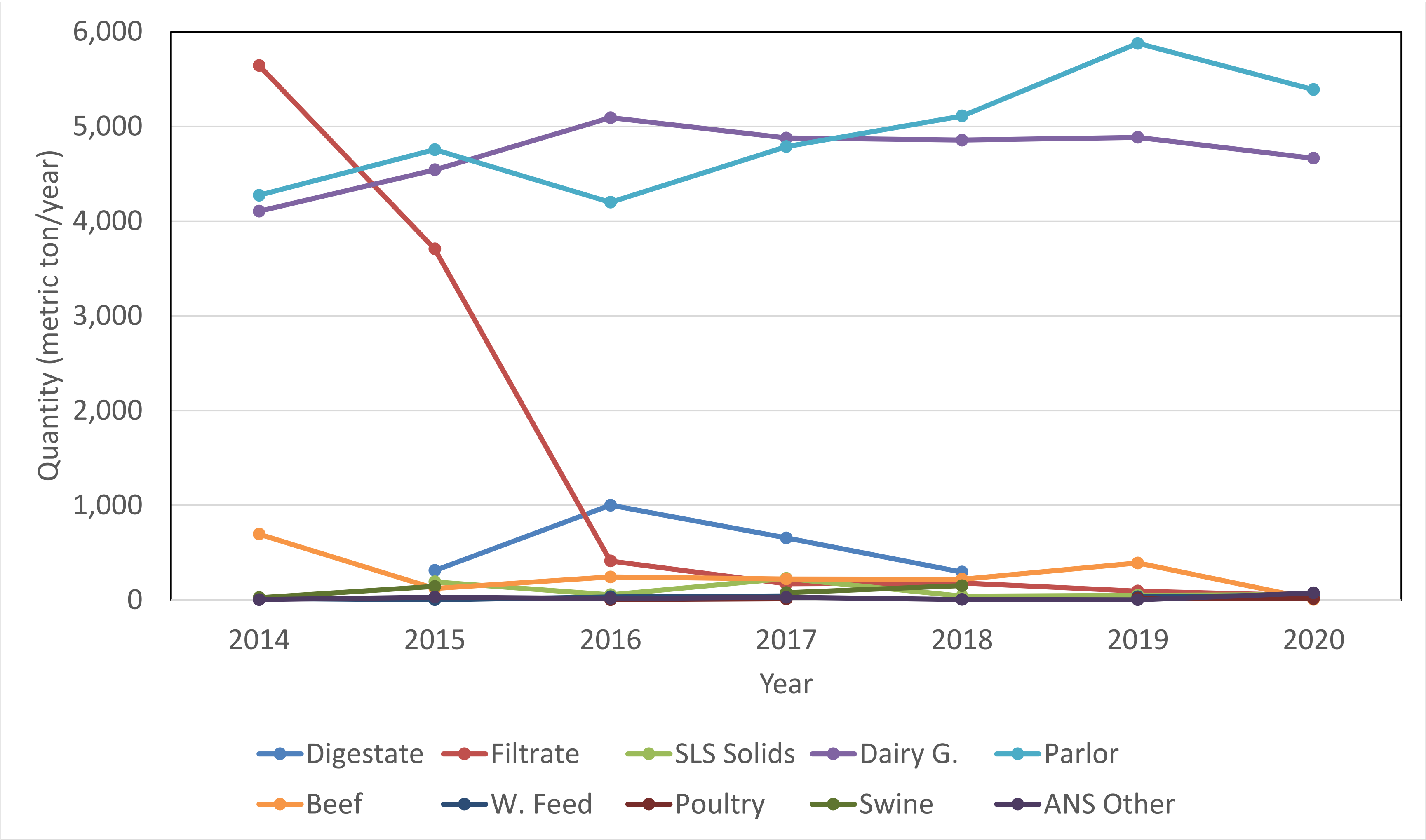


SCAD Manure Feedstocks

Year	Manure Pit (kg/d)						
	Dairy G.	*Parlor**	*Beef*	*Waste Feed*	*Poultry*	*Swine*	*ANS Other*
2014	11,463	25,466	6,354	4,069		12,645	179
2015	12,647	27,034	4,784	1,069		4,537	741
2016	13,844	21,659	3,914	3,426	568		441
2017	13,307	20,612	2,394	1,451	1,071	25,682	919
2018	13,205	23,907	2,878			17,275	688
2019	13,287	21,993	3,432	1,847	1,935		1,562
2020	12,678	21,269	3,053	3,159	1,950		3,022
Average	**12,919**	**23,134**	**3,830**	**2,503**	**1,381**	**15,035**	**1,079**
St. Dev	**705**	**2,222**	**1,255**	**1,105**	**589**	**7,653**	**888**

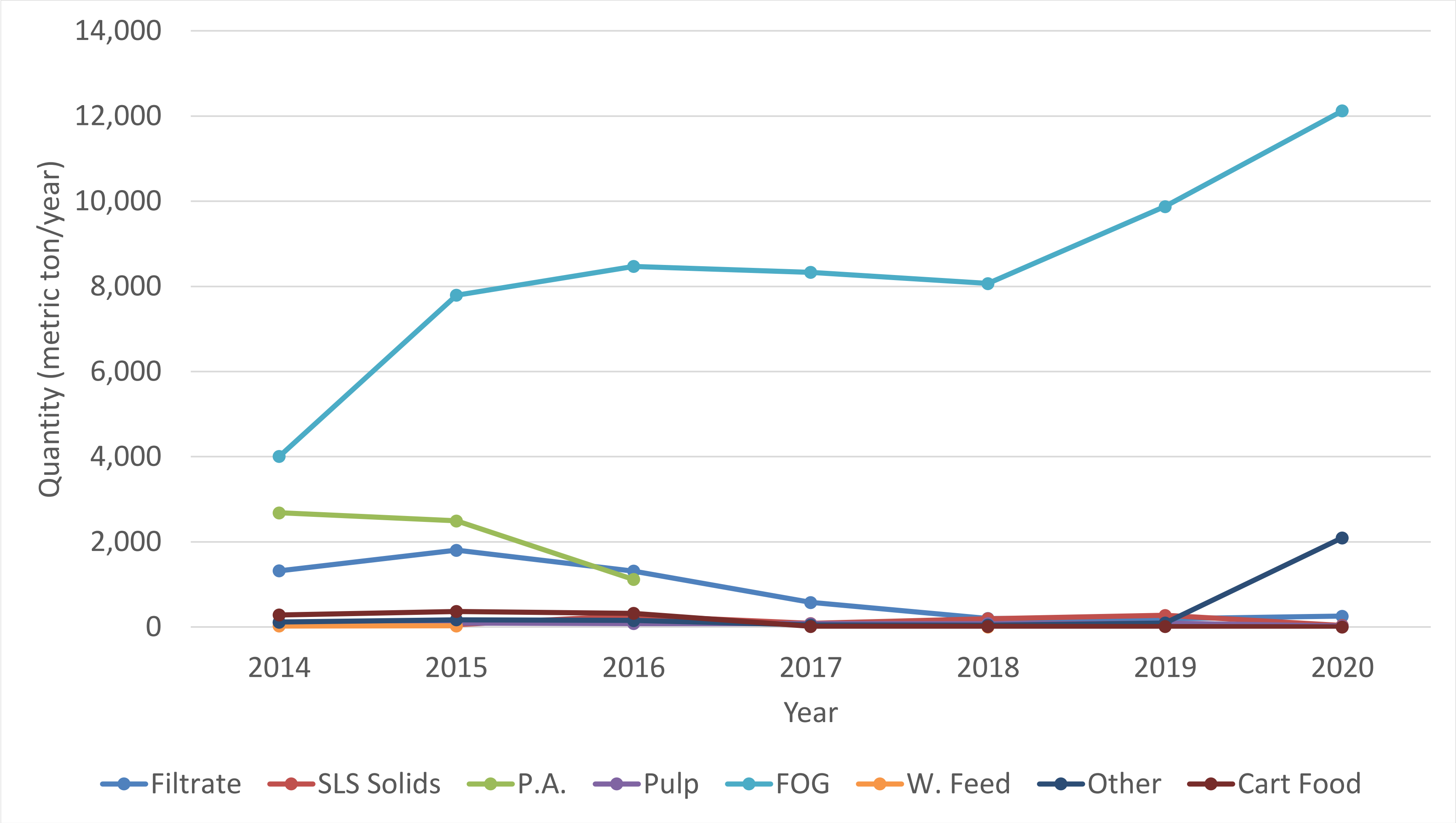
Pre Consumer Food Waste

Post Consumer Food Waste

Fruit & Vegetable Waste

FOG

Feedstock received in the SCAD food pit



SCAD Food Waste Feedstocks

Year	Food Pit (kg/d)					
	P.A.	*Pulp*	*FOG*	*Waste Feed*	*Other*	*Cart Food*
2014	11,547	1,112	18,952	2,017	10,870	2,151
2015	11,093	1,272	35,270	2,146	2,849	1,845
2016	11,345	1,317	35,052		1,341	2,417
2017		2,013	32,703		1,067	121
2018		1,656	31,780	1,620	1,498	117
2019		2,088	34,277		2,857	92
2020		1,630	40,428		13,222	67
Average	**11,328**	**1,584**	**32,637**	**1,928**	**4,815**	**973**
St. Dev	**186**	**346**	**6,143**	**224**	**4,663**	**1,020**

“Other” Food Waste

- Beverage processing waste
- Packaging material
- Slaughterhouse material
- Tortilla’s
- Greenhouse byproducts
- Research byproducts
- Depackaging slurry

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- Challenges
  - Packaging & contamination
  - Debris
  - Seasonality
  - Cleaning agents
  - Consistency
  - Unloading
  - Water content
- Pretreatment
  - Depacking
  - Grinding/maceration
  - Sterilization
  - Other

Comparison of Manure and Food

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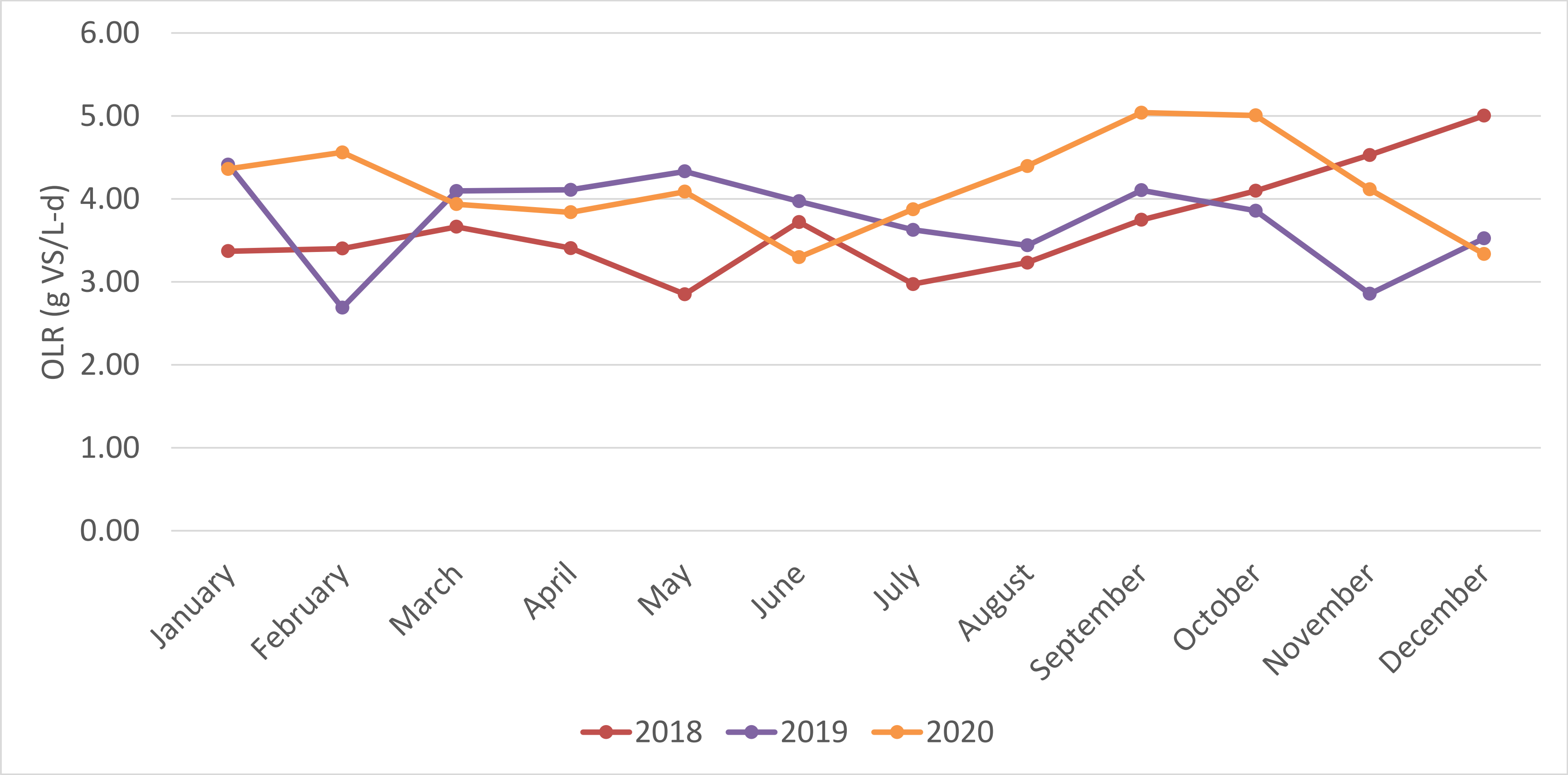
Year	Manure Pit (Metric ton/year)	Food Pit (Metric ton/year)	Total (Metric ton/year)	Food Pit (%)
2014	14,763	8,533	23,297	37%
2015	13,805	12,800	26,605	48%
2016	11,059	11,726	22,785	51%
2017	11,109	9,129	20,238	45%
2018	10,859	8,605	19,464	44%
2019	11,353	10,539	21,893	48%
2020	10,332	14,531	24,863	58%
Average	11,897	10,838	22,735	47%
St. Dev	1,683	2,294	2,499	7%

Daily OLR



6.00
5.00
4.00
3.00
2.00
1.00
0.00
OLR (g VS/L-d)
January
February
March
April
May
June
July
August
September
October
November
December
2018
2019
2020

Sample of Feedstock Characterization

Feedstock	TS (mg/L)	VS (mg/L)	pH
Parlor Manure	63,844	52,742	7.01
Beef	462,152	393,620	8.64
Dairy Gutter	162,268	142,940	8.23
FOG	120,191	105,384	5.50
Food Other	219,447	193,795	5.41
Pineapple	127,389	114,749	3.91
Pulp	275,459	262,105	4.36

Combined heat & power unit (CHP)

Digester Contribution to Campus Sustainability

- Electrical energy – 2,400 MW/yr
  - 10-20% of energy produce needed to operate system
- Thermal energy – +3,000 MW/yr
  - <50% of the thermal energy needed to maintain temperature
- Greenhouse gas reduction (carbon credits)
- Landfill & wastewater diversion (>10,000 ton/yr)
- Recycling of carbon and nutrients

Annual Biogas & Energy Production

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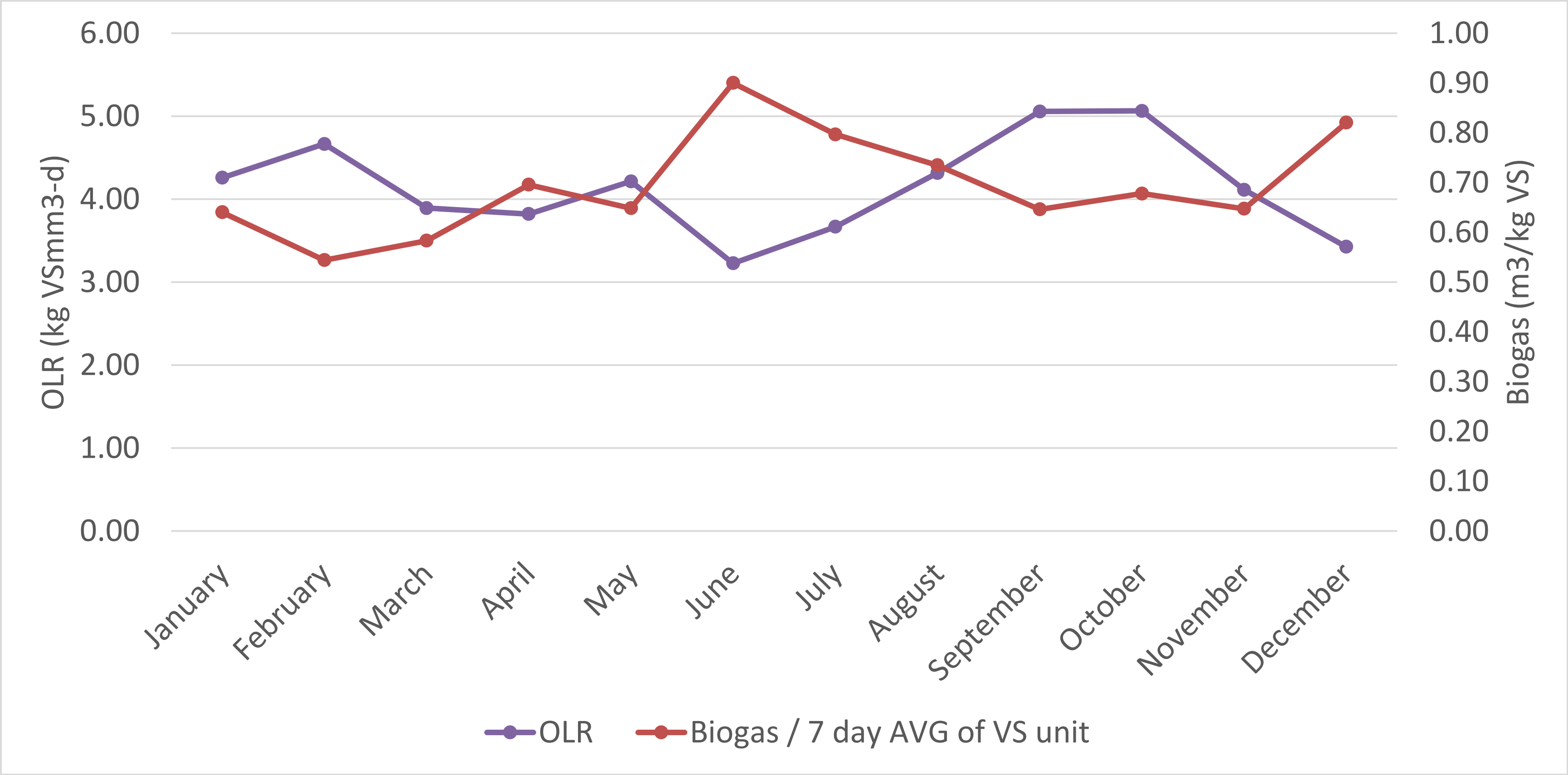
Year	HRT (days)	Temp (F)	pH	CH4 (%)	H2S (PPM)	CHP Daily total (SCFd)	Daily Electrical Power Generated (kWh)
2014	27	103	7.9	63%	360	82,303	4,880
2015	21	103	7.4	61%	433	106,810	6,431
2016	23	102	7.5	62%	667	136,744	7,407
2017	26	102	7.7	65%	421	103,138	6,994
2018	27	103	8.1	66%	387	125,635	7,342
2019	26	103	8.0	64%	520	121,743	6,632
2020	22	98	7.1	66%	652	131,387	7,518
Average	25	102	7.7	64%	491	115,394	6,743
St. Dev	2	2	0.3	2%	116	17,630	849

7 Days Average in 2020: Biogas vs OLR



Takeaways from Our Experience

- Plan for feedstock change
  - Seasonality
  - Market driven
  - Competition
- “Clean” feedstock
- Budget for sufficient labor

Questions

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TEACH AD – Educational Assistance

- In person workshops (2)
  - Onsite events
  - Tour of the site
  - **April 2022: Kishwaukee Water Reclamation District for**
  - **Visit erc.uic.edu/bioenergy/teachad/in-person-workshops/**
- Webinars (10)
  - Will cover different aspects of an anaerobic digestion project
  - **Join us again in July for our 6th Webinar**
  - **Visit erc.uic.edu/bioenergy/teachad/teach-ad-webinars/**
- Project profiles (8)
  - Will highlight successful AD projects
  - **First two project profiles covering UW Oshkosh and Urbana Champaign Sanitary District**
  - **Visit https://erc.uic.edu/bioenergy/teachad/project-profiles/**

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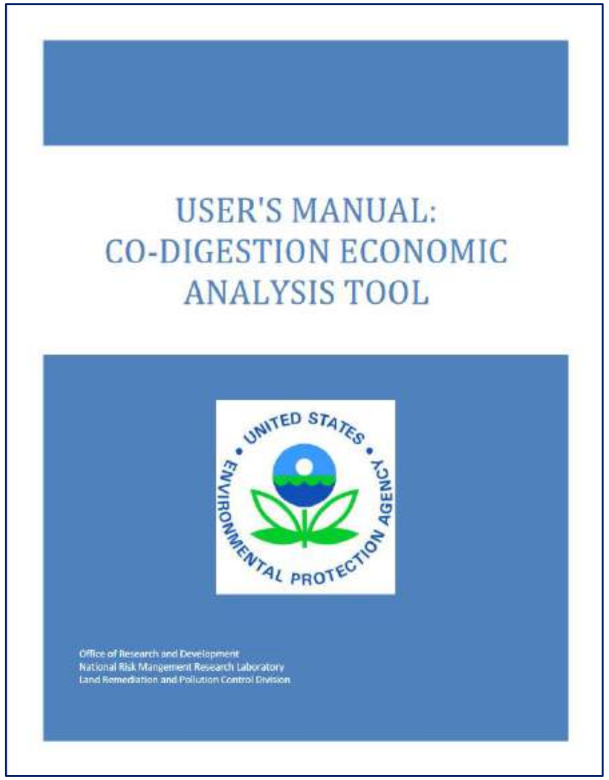
TEACH AD – Technical Assistance

- Anaerobic Digestion Technical Assessments
  - Tailored technical assistance to each client
  - Initial economic and physical feasibility assessment for (co)digestion of organic wastes
  - Assess opportunity for using U.S. EPA's Co-Digestion Economic Analysis Tool (CoEAT)
  - Report presentation and follow up with next steps

INITIAL DATA REQUEST → MEETING WITH THE SITE → REPORT PRESENTATION → FOLLOW UP


USER'S MANUAL:
CO-DIGESTION ECONOMIC
ANALYSIS TOOL

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Office of Research and Development
National Risk Mangement Research Laboratory
Land Remediation and Pollution Control Division

Visit erc.uic.edu/bioenergy/teachad/technical-assessments/

TEACH AD - Contact

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Questions & Answers

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Associate Professor

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TEACH AD Webinar Series

Join us again in **July** for our **6th Webinar**!

Thank You

Please fill out our survey.

A recording of today's webinar will be posted, and you will be emailed a link by early next week.

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Thank You

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