MSU South Campus Anaerobic Digester
2 Years of Operation Experience

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South Campus Anaerobic Digester Site

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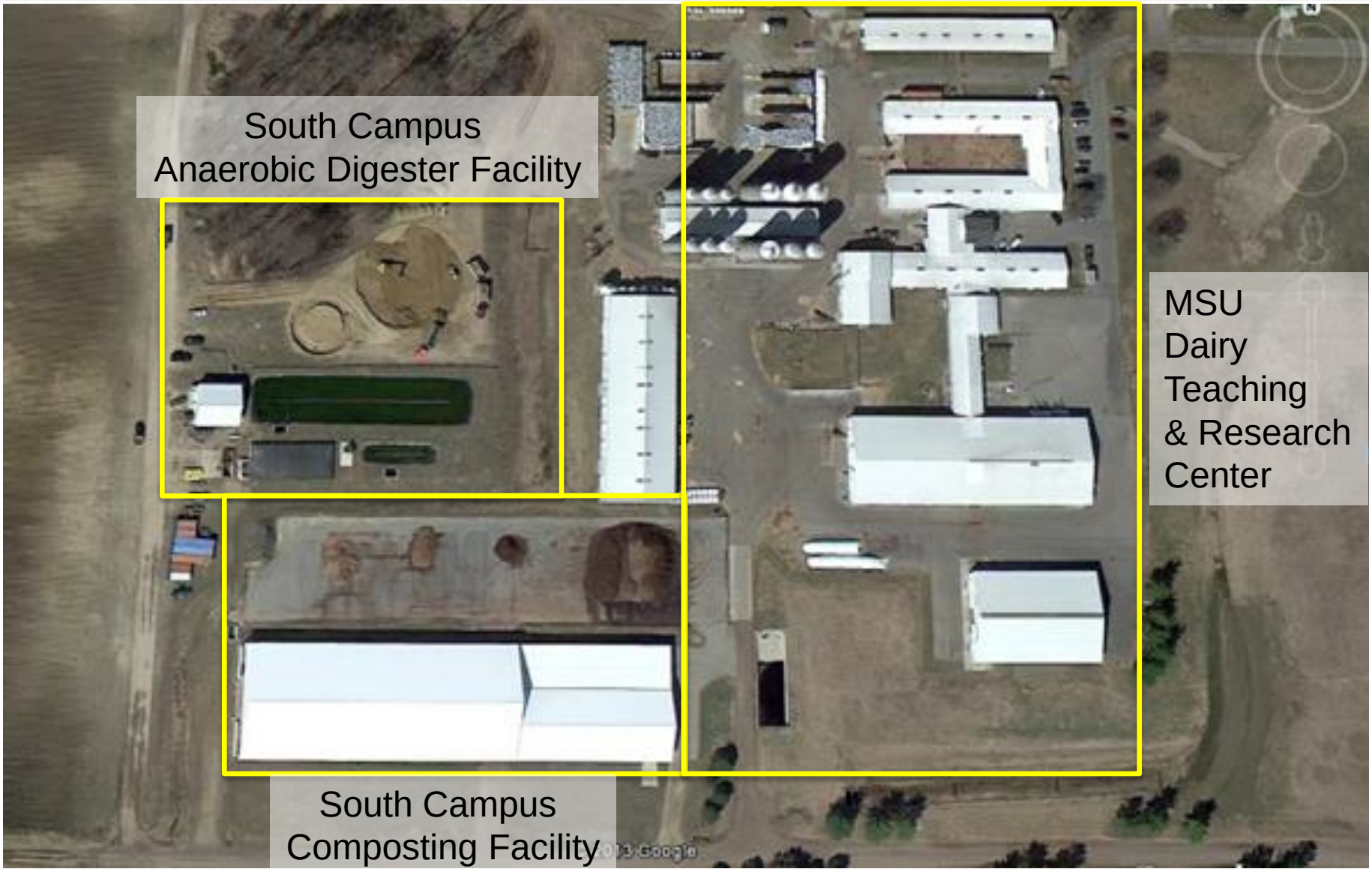

Google Earth, July 2013

Why anaerobic digestion?

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- 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
- MSU is leader in education, research & outreach

Key sources of organic waste on campus

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- **Campus Living**
  - Roughly 17,000 students live on campus
  - Culinary Services serves over 37,000 daily, 152,000 weekly
  - 9 dining halls have all access from 7AM to 12AM
  - 23 coffee shops/convenience stores/retail foods
- **University Farms**
  - Dairy, Swine, Beef, Sheep, Poultry, Equine
  - Pavilion

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MSU South Campus Anaerobic Digester

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- Digester tank
  - 52’ * 26’ plus cover (400,000 gallons)
- Digestate storage tank
  - 101’ * 42’ plus cover (2.1 million gallons)
- CHP system
  - 400 kW electrical production & 450 kW of thermal energy recovery
  - Offset power at 8 to 10 south campus facilities
  - 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

Discussion Topics for Today

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- Feedstock variability
- O&M challenges
- Mechanical changes
- Operational data

South Campus AD Feedstocks

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MSU South Campus Digester Feedstock

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Feedstock	TS (%)	Planned	
		(ton)	(%)
Dairy manure	12	7,000	43
Fruit & vegetable	11	3,900	24
FOG	20	5,000	30
Cafeteria food waste	10	750	3
TOTAL		16,650	

Pre Consumer Food Waste

Post Consumer Food Waste

Fruit & Vegetable Waste

FOG

MSU South Campus Digester Feedstock

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Feedstock	TS (%)	Planned		2014	
		(ton)	(%)	ton)	(%)
Dairy manure	12	7,000	43	16,000	67
Fruit & vegetable	11	3,900	24	2,900	12
FOG	20	5,000	30	4,400	19
Cafeteria food waste	10	750	3	430	2
TOTAL		16,650		23,730	

Digester Feedstock Deliveries

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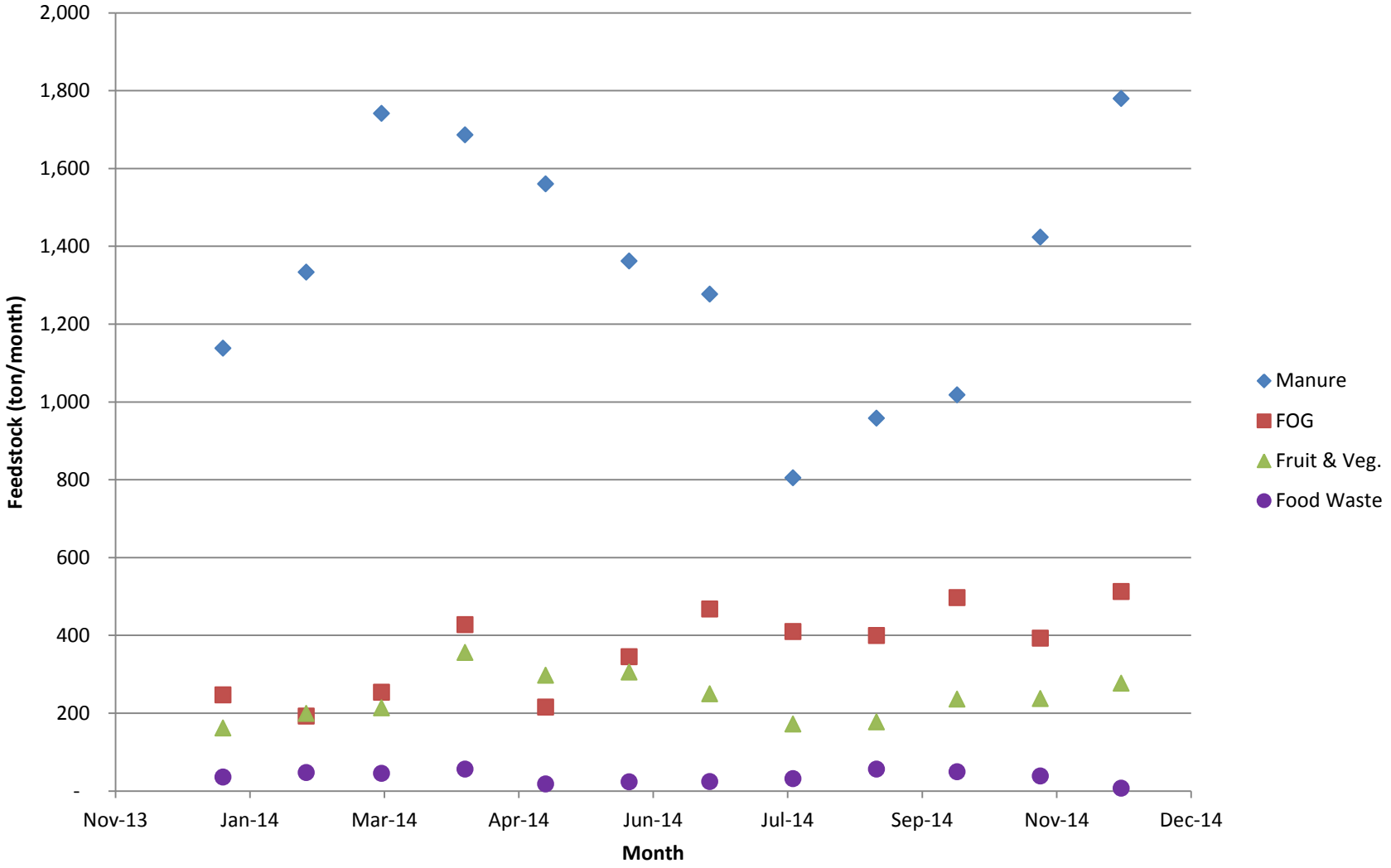

MSU South Campus Digester Feedstock

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Feedstock	TS (%)	Planned		2014		2015	
		(ton)	(%)	ton)	(%)	(ton)	(%)
Dairy manure	12	7,000	43	16,000	67	9,525	43
Fruit & vegetable	11	3,900	24	2,900	12	2,900	13
FOG	20	5,000	30	4,400	19	3,730	17
Cafeteria food waste	10	750	3	430	2	440	2
Milk processing waste	12					5,475	25
Packing material	90					60	
TOTAL		16,650		23,730		22,070	

Other materials include waste feed, eggs and one-offs

Feedstock Challenges

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- Dilution (FOG)
- Particle size (F&V waste)
- Temperature (F&V waste)
- Debris/inorganics
  - Stones/grit
  - Hammers/saw blades
  - Grill grates/salad tongs
  - Plastics
  - Gloves

Maintenance & Operation

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Operation & Maintenance

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- Estimated O&M - $107,000
  - Range of bidders $35,000 to $107,000
  - Mean was $40,000

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  - Labor - $131,500
    - M-F averaging 12 hours per day
    - S-S averaging 5 hours per day (not anticipated)
    - Includes contract negotiations/billing/report

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  - CHP - $42,000 ($0.015/kWh)
    - Premature spark plug failure (700-1000 hrs), cost $180
    - Current spark plug life between 2,000 & 4,000 hrs

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  - AD mixers - $18,000 - $27,000
    - Confined space entry, 2x per year
    - Considering alternative options to reduce service intervals

Mechanical & Design Changes

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Key Mechanical & Design Changes

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Complete/in process

- Inline grinder addition
- Plumbing/process flow changes
  - Installation of cleanouts
  - Raised piping above grade
    - Facilitate service
    - Reduced line friction (90^{o} elbows)
- Mix tank mixer replacement
- Insulation of biogas cleanup
- Premature CHP major service

Key Mechanical & Design Changes

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Planned

- Installation of depackaging equipment
- Digester mixer modification
  - Service
  - Energy efficiency
- Nutrient separation

Operational Data – 2014 & 2015

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Operational Data – 2014 & 2015

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Year	Temp (°F)	pH	OLR (g VS/L-d)	Biogas (scfm)	Methane (%)	Electrical (kW/hr)
2014	103.0	7.9	3.14	54	63.4	199
2015	103.7	7.4	3.52	82	61.3	260

2015 OLR & kWh

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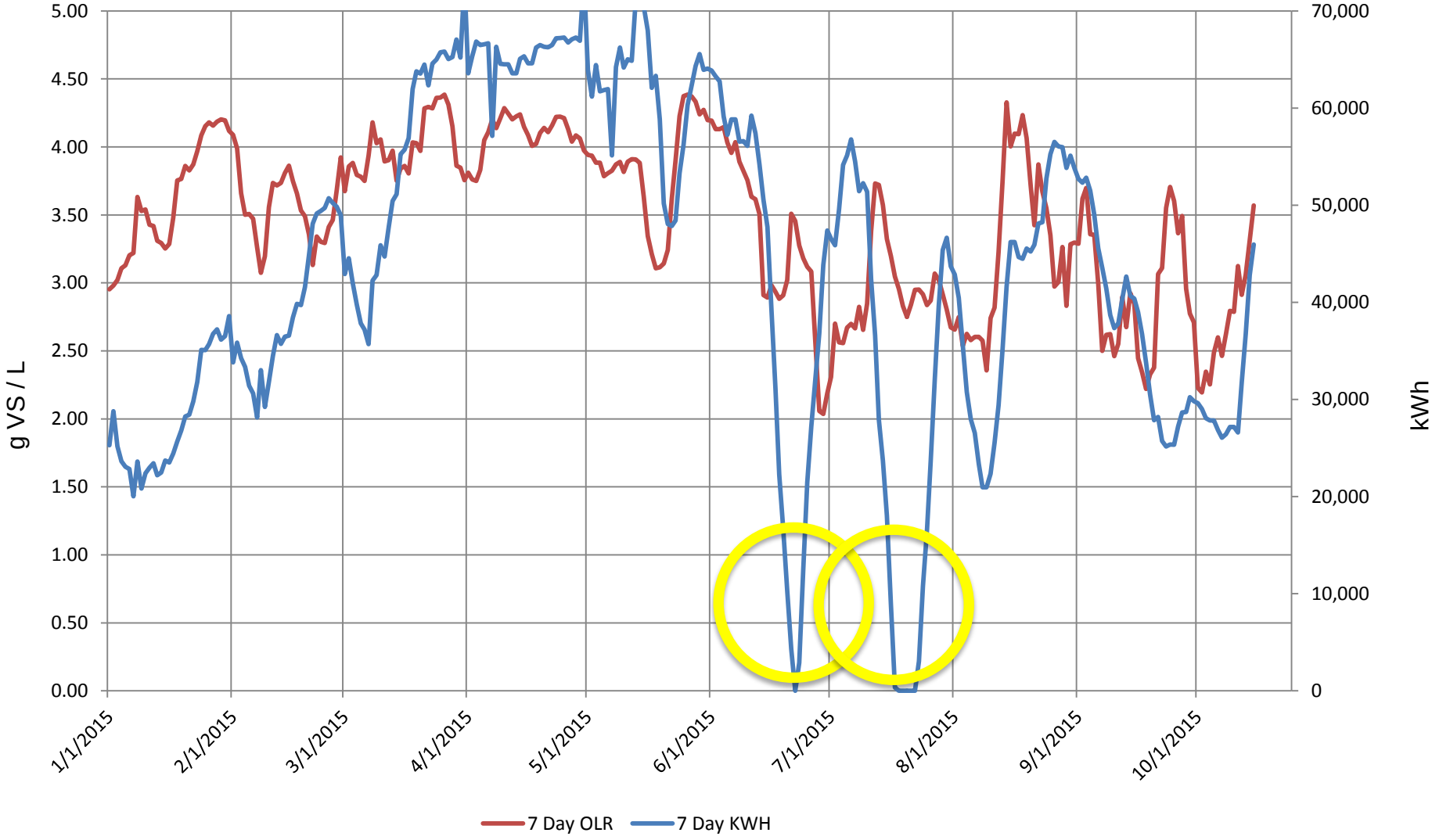

2015 Biogas Quantity & Quality

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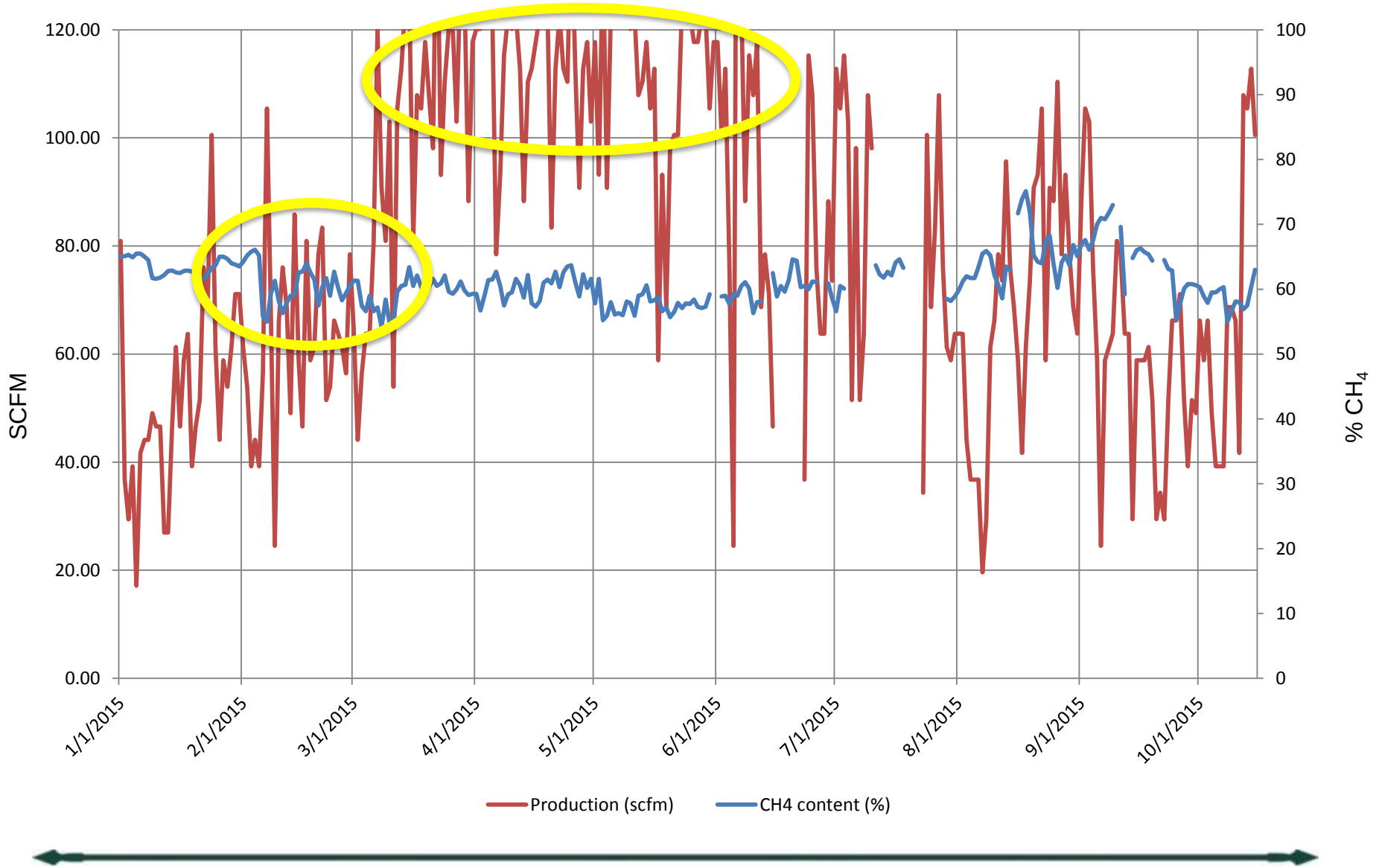

Digester Contribution to Campus Sustainability

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- Electrical energy – 3,000 MW/yr
  - 10% of energy produce needed to operate system
  - 7.3% of the 2015 energy transition goal (based on 08-09)
  - Renewable energy certificates – 3,000 MW/yr
- Thermal energy – +3,000 MW/yr
  - <50% of the thermal energy needed to maintain temperature
- Greenhouse gas reduction (carbon credits)
- Landfill & wastewater diversion (≈14,500 ton/yr)
- Recycling of carbon and nutrients

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- Greenhouse gas reduction (carbon credits) 
- Landfill & wastewater diversion **12,500 ton/yr**
- Recycling of carbon and nutrients 

Questions?

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