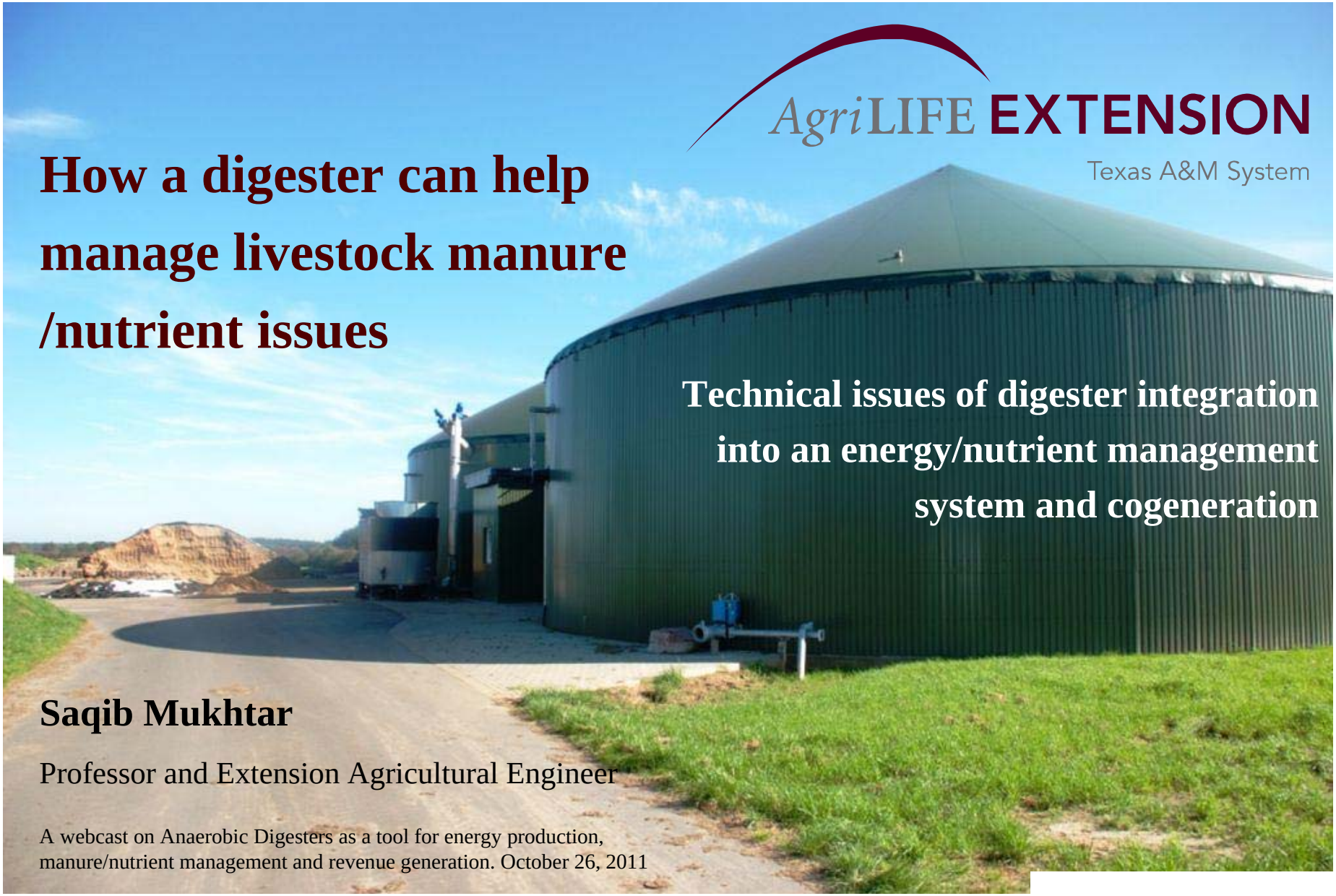

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How a digester can help manage livestock manure /nutrient issues

Technical issues of digester integration into an energy/nutrient management system and cogeneration

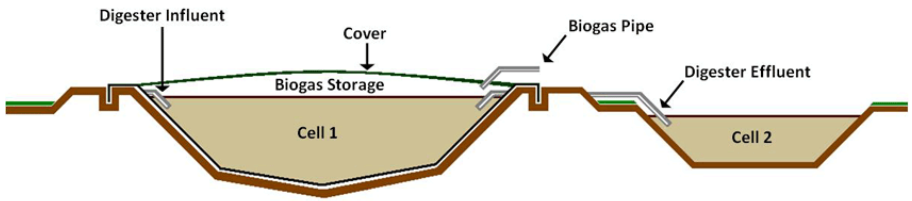
Saqib Mukhtar

Professor and Extension Agricultural Engineer

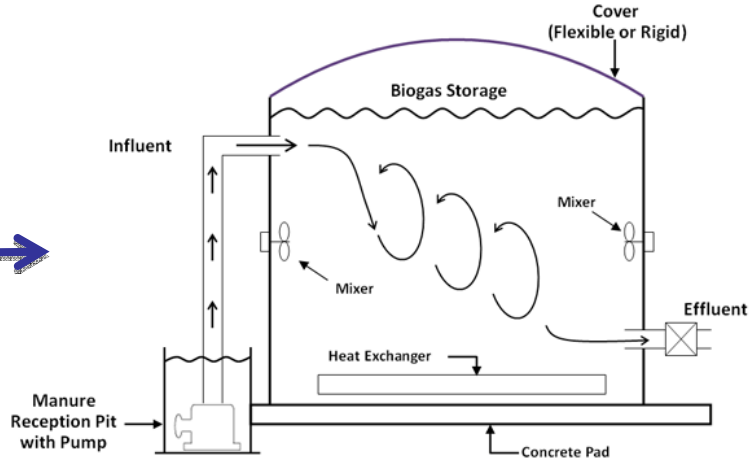
A webcast on Anaerobic Digesters as a tool for energy production, manure/nutrient management and revenue generation. October 26, 2011

Improving Lives. Improving Texas.

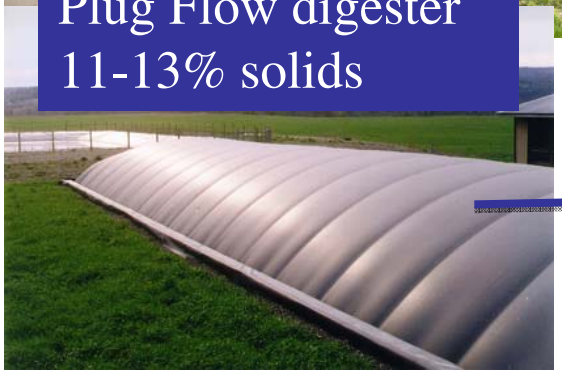
Covered Lagoon digester-Up to 3% solids (ambient temps)

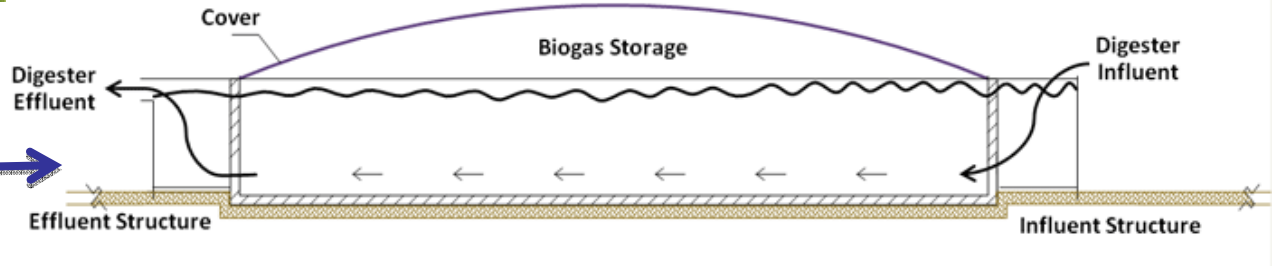


Complete Mix (CSTR) digester 3-10% solids (Mesophylic- ~ 95 ^{O}F



Plug Flow digester 11-13% solids





Schematics Source: AgSTAR-USEPA

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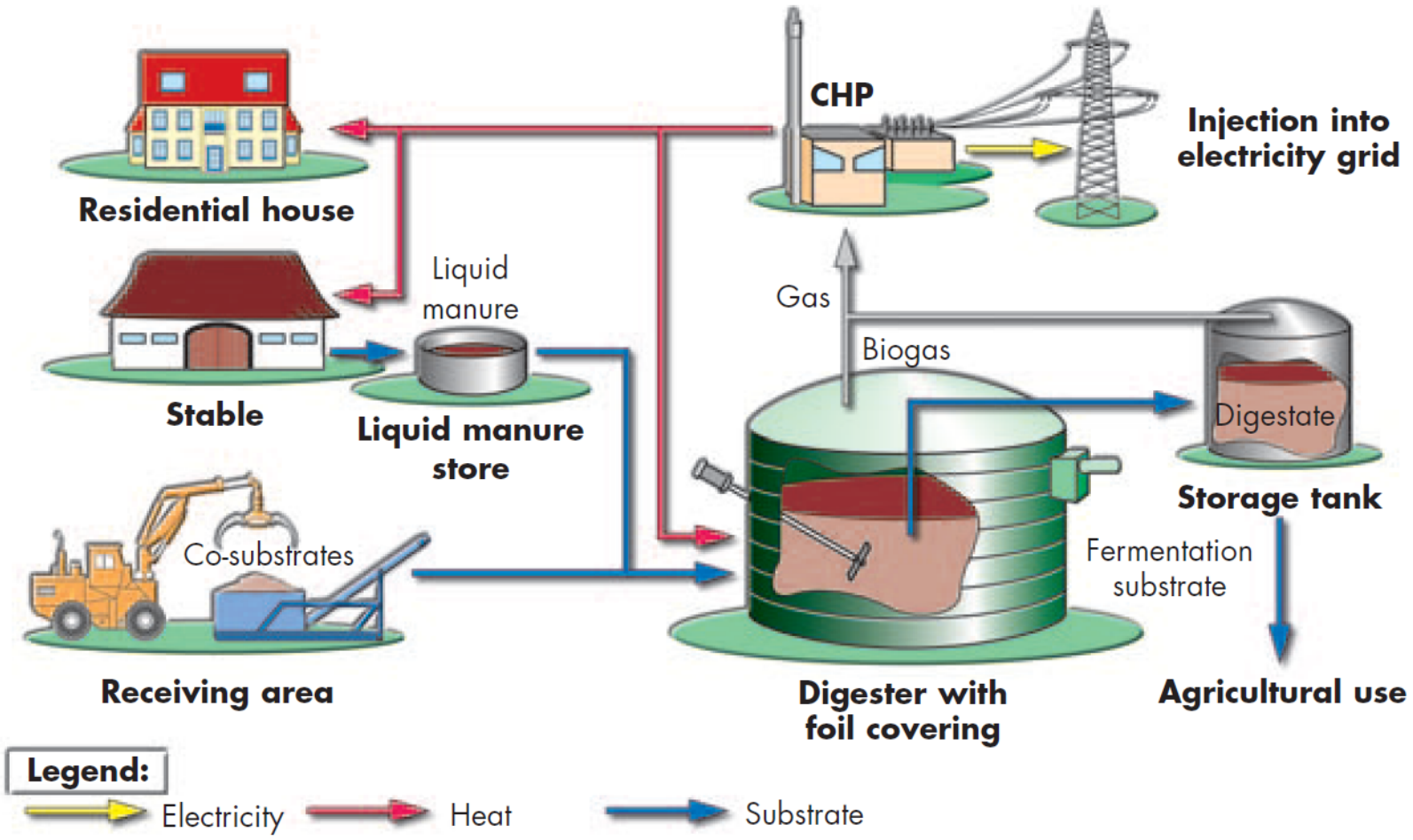
Biogas plant with co-fermentation



Source: Biogas – an Introduction. 2009. Federal Ministry of Food, Agriculture and Consumer Protection, Germany

Typical Net Biogas Production and Fuel Equivalents

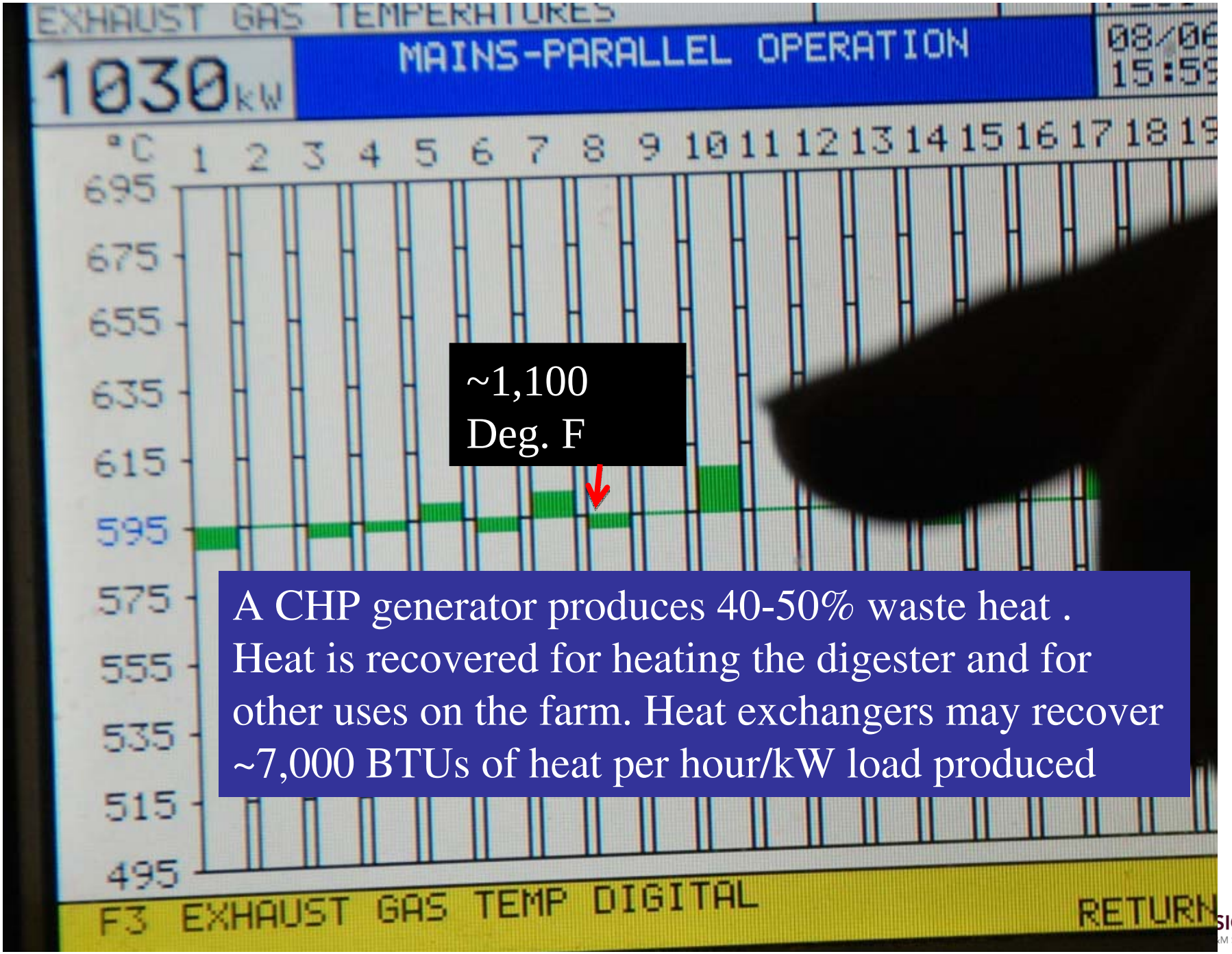
(Livestock waste facilities handbook, MWPS-18, 1985)

- 39 cubic feet (ft^3) Biogas per day per 1000 lb body wt. or
- **51 cubic feet/1,300 lb cow/day**
- 54% methane
- 26,910 Btu/day/cow
  - Fuel Equivalents
- Natural gas ~28 ft^3 /day
- Propane ~ 0.29 gal/day
- Diesel- 0.18 gal/day
- ~1.6 kWh/day/cow @ 20% Conversion Efficiency (CE)

EPA-AgSTAR FarmWare V3.5, 2010

- 57.5% methane for dairy farms
- Electricity- 35% CE.

>40% CE possible with new generation ICE Generators.
~ 3kWh/day/cow or ~1100 kWh/yr/cow **Electricity Production is possible**


EXHAUST GAS TEMPERATURES
1030 kW
MAINS-PARALLEL OPERATION
08/06
15:59
°C
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
695
675
655
635
615
595
575
555
535
515
495
~1,100
Deg. F
A CHP generator produces 40-50% waste heat . Heat is recovered for heating the digester and for other uses on the farm. Heat exchangers may recover ~7,000 BTUs of heat per hour/kW load produced
F3 EXHAUST GAS TEMP DIGITAL
RETURN

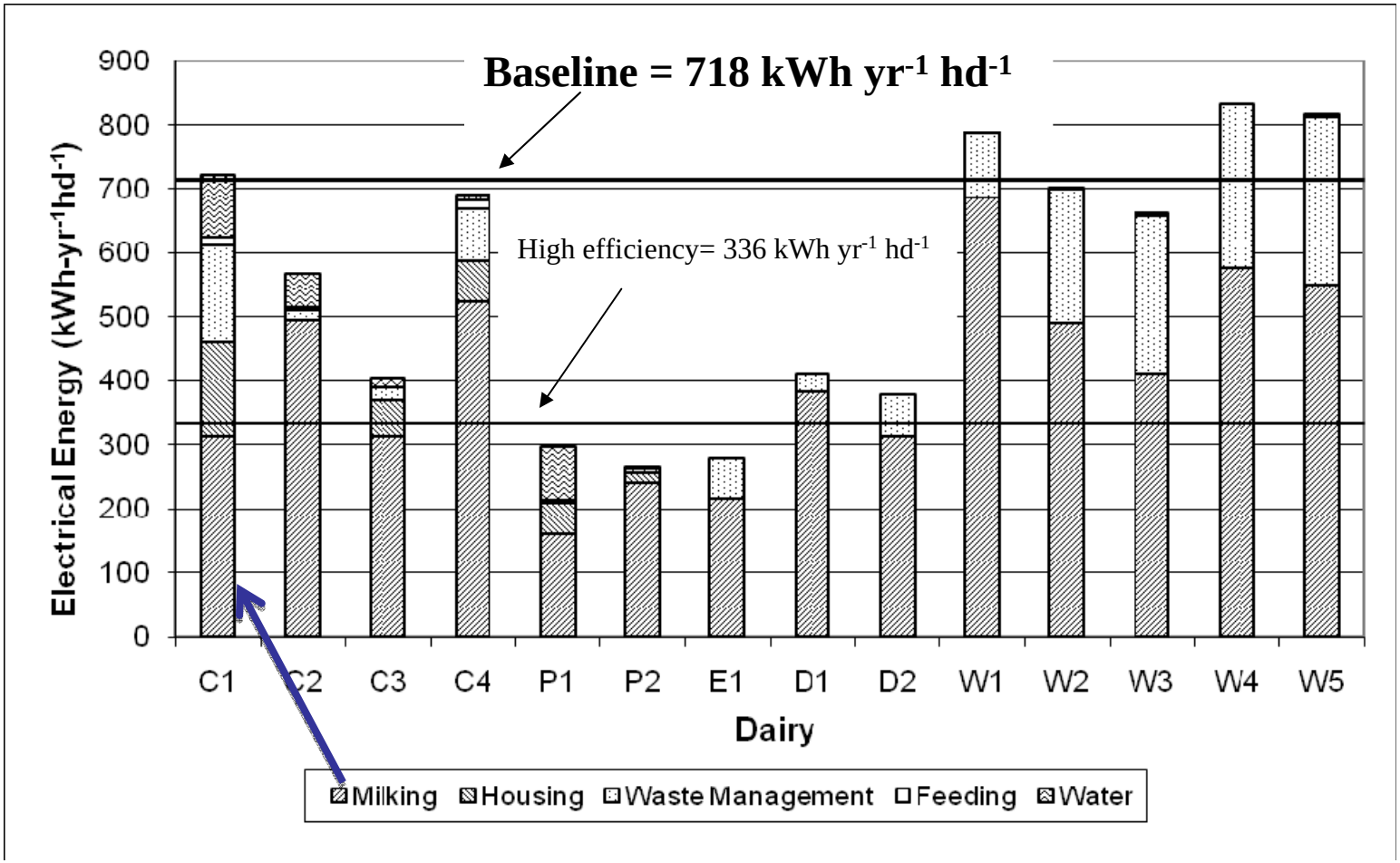
Electricity use and price, by region and commodity (Averages)

Dairy Operations			
	Per farm (kWh/yr)	Per head (kWh/yr)	Price ($/kWh)
United States	128,918	1,048	0.069
West	288,702	893	0.058
Midwest	101,175	1,102	0.064
South	159,349	791	0.065
Northeast	106,418	1,080	0.085

Source: Economic Research Service-USDA. 2011. *Climate Change Policy and the Adoption of Methane Digesters on Livestock Operations . ERR-111.*

Biogas to electricity potential - 1,100 kWh/yr/cow

Total dairy electrical energy usage subdivided according to different parts of the operation



Horizontal lines indicate the range of total electrical energy usage values estimated using the USDA farm energy calculator (C1-C4 = Central Texas; P1-P2 = Texas Panhandle; E1 = Northeast Texas; D1-D2 = Northern San Joaquin Valley; W1-W5 = Central San Joaquin Valley).

Source: Capareda, Mukhtar, Engler and Goodrich. 2010. Energy usage survey of dairies in the southwestern United States. Applied Engineering in Agriculture. Vol. 26(4): 667 - 675.

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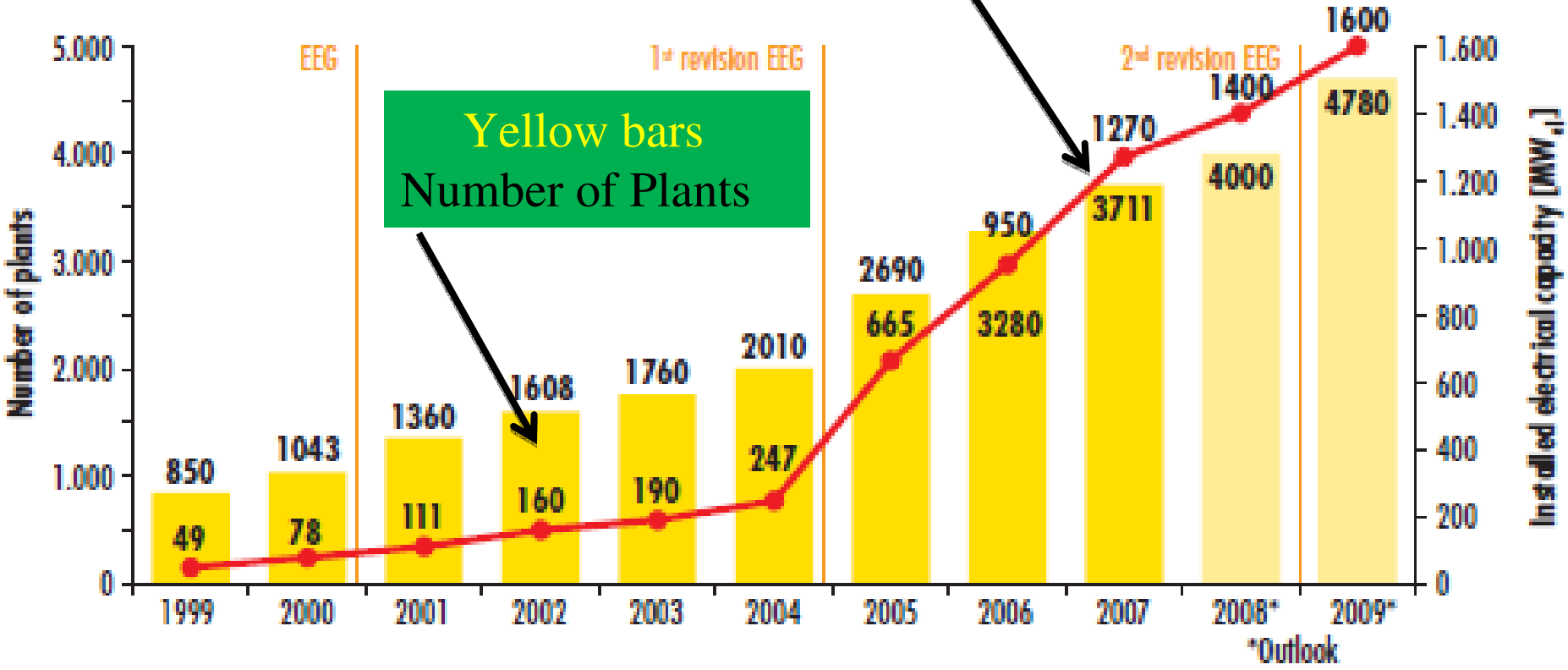
In 2010
162 total ADs in USA
Source: AgSTAR-USEPA

Major Organic Substrates Used German Digesters
41% Animal Manure- 47% other biomass

Redline: Electrical Capacity, Mega Watt



Source: Biogas – An introduction. 2009. Federal Ministry of Food, Agriculture and Consumer Protection, Germany

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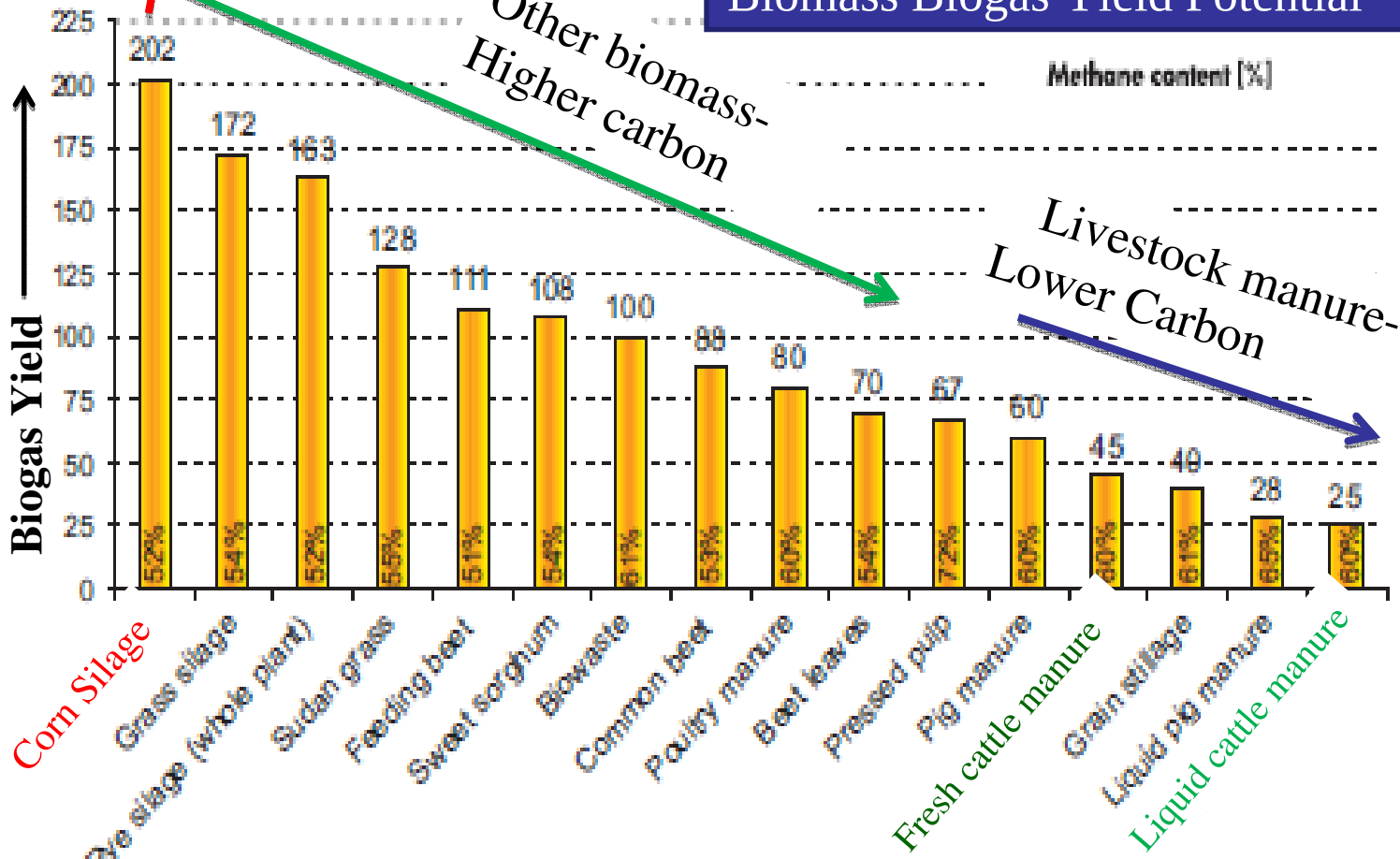
Corn feed and fodder Issues

"Excuse me. I'm going to need this to run my car."

Michael Ramirez © IBDeditorials.com/cartoons

Biomass Biogas Yield Potential



Graph Source: Biogas – an Introduction. 2009. Federal Ministry of Food, Agriculture and Consumer Protection, Germany

Digester Influent Issues

Digester Feedstock and Nutrient Management Issues

Scraped and Piled
Soil (inert material) content.
Water requirements

Open lot Corrals ~30-40% of total manure generated on concrete apron?

Vacuumed Slurry-
Bedding type-Sand or biomass?

Matching manure to digester
Matching digestate to nutrient management plan

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Digester Feedstock and Nutrient Management Issues…

- Nutrient quantities in raw and digested manure remain nearly unchanged
- Biochemical changes during digestion may enhance nutrient availability to crops
- For co-digestion, dry matter and nutrient content should be known for each substrate for proper nutrient management planning

Digester Feedstock and Nutrient Management Issues…

Nitrogen composition of raw and digested dairy slurry

(Ave. of 52 weeks of raw and digested slurry)

Source: IEA Bioenergy, Lukehurst et al., 2010.

	(g/kg)	(g/kg fresh)	(g/kg fresh)	(% Total N)	
Feedstock Raw	72.2 7.2%	3.5 7.2 lb/ton	2.0 4 lb/ton	67.0	7.4
Digestate Digested	59.3 5.9%	3.6 7.2 lb/ton	2.4 4.8 lb/ton	80.5	7.9
Change →	−17.9%	+2.8%	+20%		
Standard deviation feedstock	8.50	0.52	0.36		0.34
Standard deviation digestate	5.22	0.48	0.43		0.23

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Digester Feedstock and Nutrient Management Issues…

- Increased nutrient content due to co-digestion may require more land due to increased N, P and K in the digested effluent
- Increased volume of total effluent from digester requires increased effluent storage volume

Digester Feedstock and Nutrient Management Issues…

Digested Effluent-Solid Separation

- Produces a dryer and stackable fraction of solids for bedding, composting or distant hauling and spreading
- Provides opportunity to reuse the solids fraction as a co-digestion material
- Reduces the volume of liquid requiring storage
- May improve N uptake from liquid fraction
- Reduces the need for extended mixing/agitation of the liquid prior to land application

Operation and Maintenance Issues/Requirements

Decanter Centrifuge

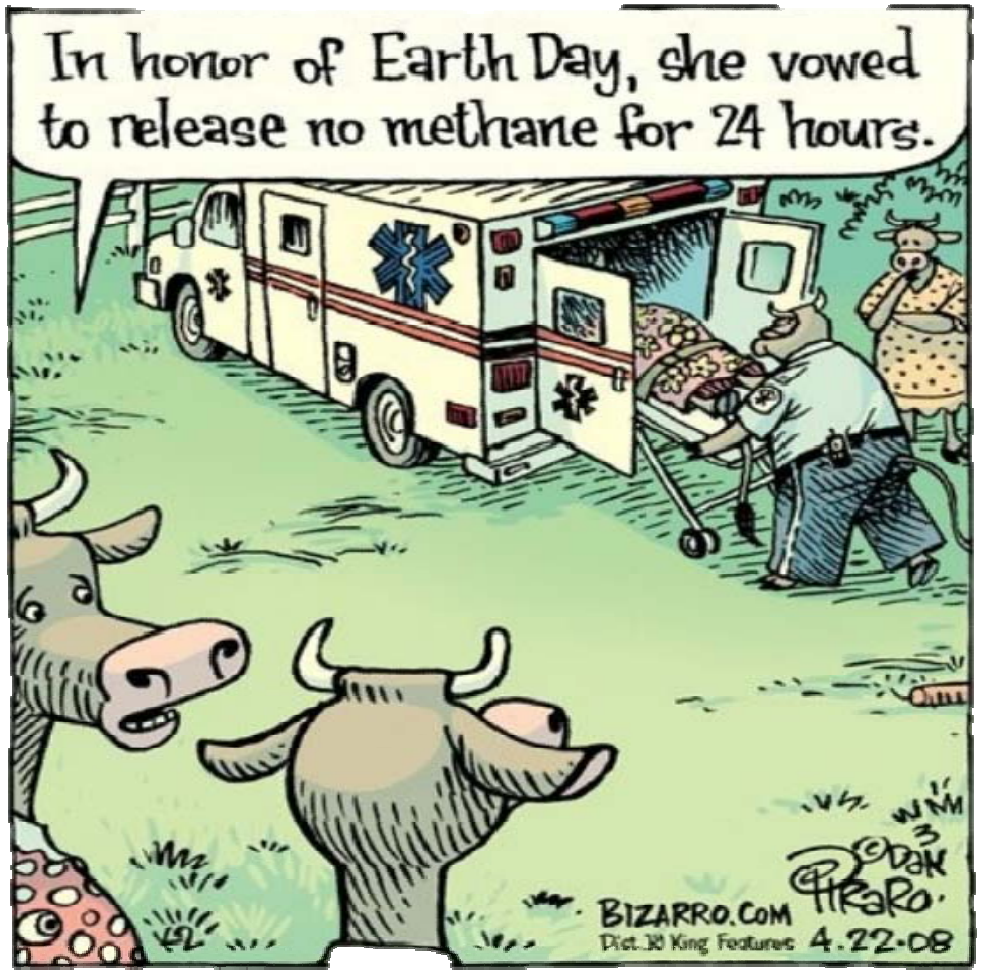
Macerator

Stacked belt drying

Feedstock mixing feeding

One trained person for up to 4 hours per day for ≤ 500 kW Generators
One trained person for more than 4 hours per day for > 500 kW Generators

Thank You!



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