



Sustainable Conservation

Mitigating Methane Emissions From Dairy Waste *The California Challenge*

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Who Is Sustainable Conservation?

- Environmental Non-Profit
- 20 Employees
- Founded in 1992
- California Focus
- Collaborative Solutions



Sustainable Conservation Approach

- Collaborative Model
 - Work in partnership w/ high impact agricultural partners
 - Dairy industry, cotton growers, etc.
- Results Focus
 - Research & Demonstration
 - Remove institutional barriers
 - New technology implementation
- Leverage Grant Funding
 - USDA, DOE, EPA, etc



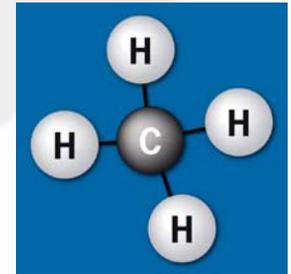
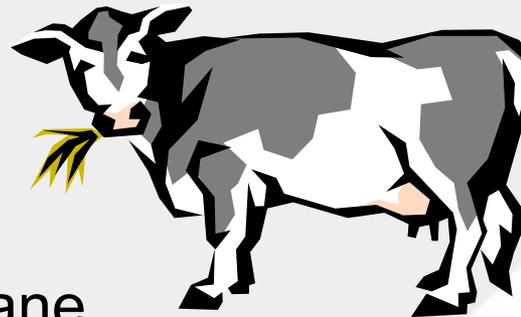
CA Dairy Industry



- CA Largest Dairy State in Nation
 - 1.8+ Million Cows on less than 2000 farms
- 120 Lbs Waste/Cow/Day
- 65 million tons/yr total from all cows
- Most manure stored in “ponds”

What Are the Major Sources of GHG Emissions on California Dairies?

- Cow Emissions
 - Eructation and Flatulence
 - Corks don't help
- Manure ponds
 - Significant CH₄
 - Biogas 60% methane
- Farm Fields
 - CO₂ from tillage
 - N₂O from fertilizer



Volume of Methane Produced in CA

- 124 billion potential cu.ft/yr from biomass
 - 2.2 billion gallons gasoline equivalent
- Only 23 billion cu ft/yr feasible to capture
- About 2/3 of that from dairies (14.6 billion)
 - Doesn't include enteric fermentation
- Crop residues are about $\frac{1}{4}$
 - 5+ billion cubic ft/yr



How to Mitigate Methane Emissions

1. Methane digesters

- Biogas to electricity
- Biomethane for biofuel
- Biomethane for renewable natural gas

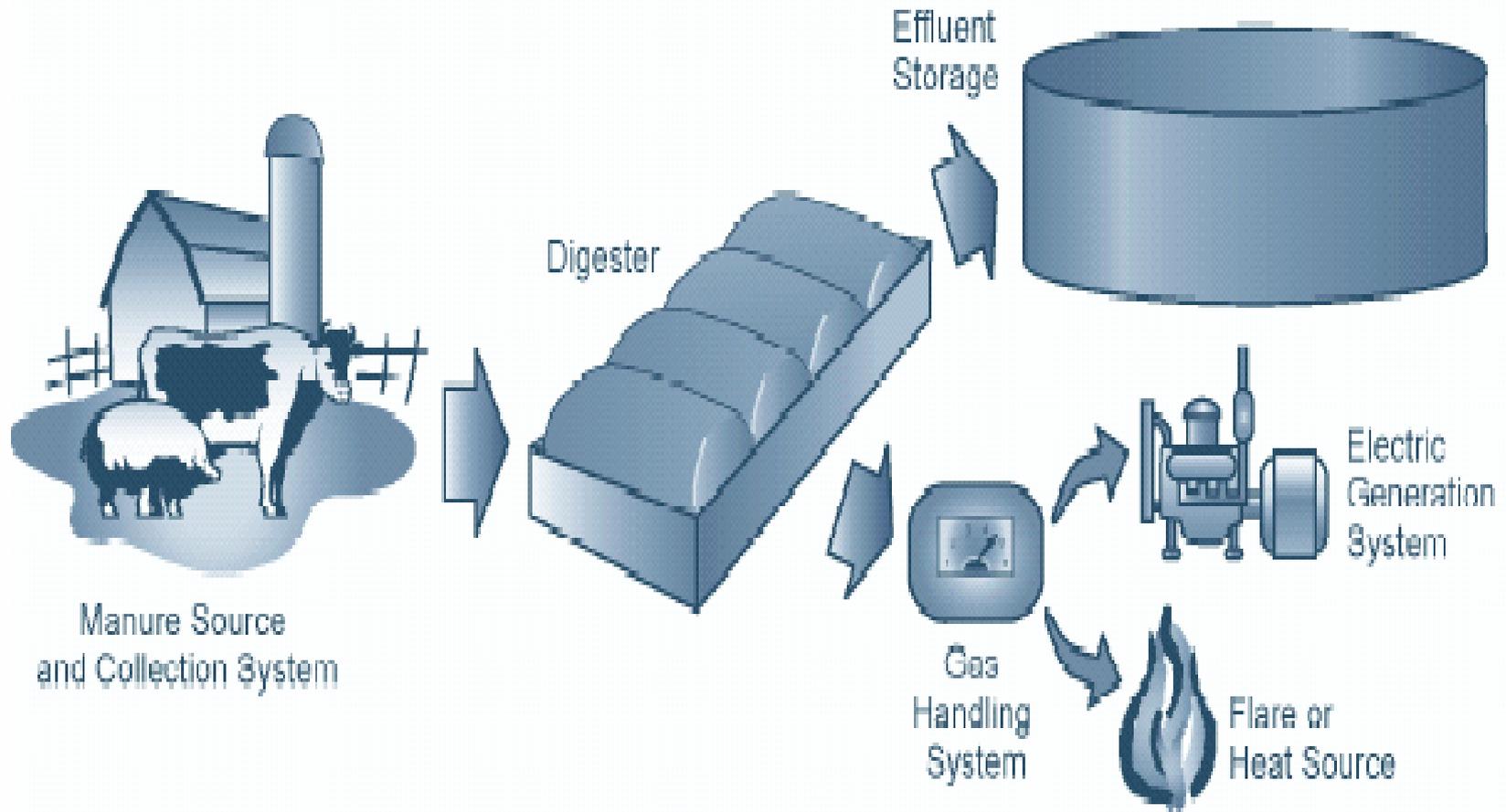
2. Lagoon cover & flare

3. Enteric methods

- Rumensin (“Gas-X” for cows)



On-farm Methane Digester Diagram



Dairy Methane for Electricity Generation



- Potential Benefits for CA
 - Electricity generation of 150 MW feasible
 - Biogas production potential of ~14 billion cu.ft/yr
- Current digester technology captures
 - Less than half energy contained in manure*
 - Opportunity to improve performance
 - Need for optimization

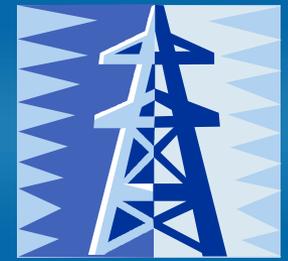
*Manure also replaces fossil fuel derived fertilizer

Short-term Success



- CEC funding resulted in dozen new digesters
- New round of funding will add half dozen more
- PG&E is buying biomethane for pipeline
- Nearly 4 MW on line with 6 MW likely by 2008
- Dairy methane credits now being traded on CCX

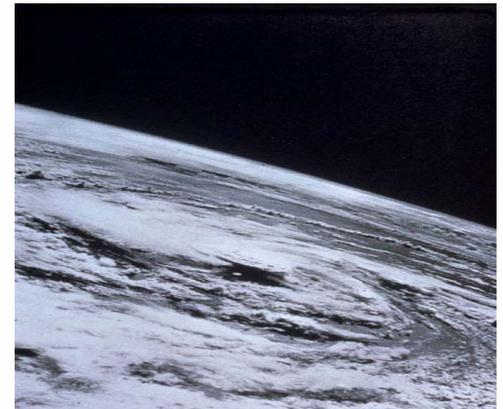
Costs and kW Capacity of Digesters Built on CA Dairies



Number of Lactating Cows	System Type	Estimated Capacity (kW)	Estimated Costs		Grant Amount	Estimated Total Cost
			(\$/kW)	(\$/animal)		
175	Cov'd lagoon	30	2500	429	\$37,500	\$75,000
237	Cov'd lagoon	75	1811	573	\$67,900	\$135,800
1050	Cov'd lagoon	120	3017	345	\$181,000	\$362,000
1258	Cov'd lagoon	150	1530	182	\$114,779	\$229,557
1600	Cov'd lagoon	160	4831	483	\$320,000	\$772,925
6000	Cov'd lagoon	250	6000	250	\$500,000	\$1,500,000
5081	Cov'd lagoon	300	4298	254	\$600,000	\$1,289,520
1100	Mixed	100	5820	529	\$200,000	\$582,000
600	Plug flow	130	3764	815	\$244,642	\$489,284
770	Plug flow	150	4413	860	\$300,000	\$661,923
1900	Plug flow	160	3281	276	\$262,449	\$524,898
1500	Plug flow	260	1469	255	\$190,925	\$381,850
4700	Plug flow	563	2747	329	\$773,175	\$1,546,350
7200	PF -2 stage	1000	4565	634	\$2,000,000	\$4,565,000
Averages		246	3575	444	\$413,741	\$936,865
Totals					\$5,792,370	\$13,116,107

How Digesters Compared to Other Distributed Generation (DG)?

- Base load power (vs wind & solar)
- Destroy pollution in creating electricity
 - In addition to offsetting fossil feedstocks
- CPUC Self Generation Report
 - Electricity from biogas highest benefit-cost ratio
 - Nearly twice photovoltaics
- Cost per ton CO₂ (equiv)
 - Range of \$2 to \$10/ton



Short-term Challenges

- Only ~1% of CA dairies have digester
- CA regulations stalling digester program
 - Water Board Issue (groundwater)
 - Air Board Issues (NOx emissions)
 - CEQA for offsite waste
 - IWMB Issues (siting/waste composition)
- Economics dependent on utilities
 - Until recently would not buy electricity

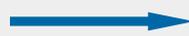


Alternative Use for Biogas

Biogas Requires Upgrading to Make Pure CH₄

Biomethane is Renewable Natural Gas

Dairy Manure



Biogas



Biomethane



Biomethane for Transportation

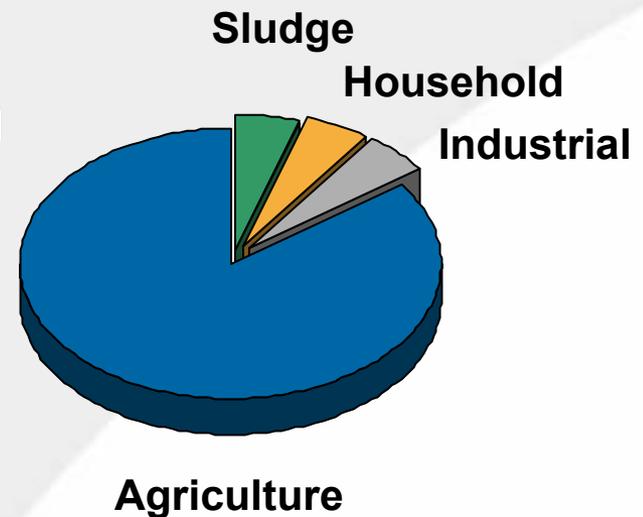
- Displaces diesel fuel or gasoline and reduces air pollution (benefit in Central Valley)
- Been done successfully at landfills
- Potential for highest net energy yield
 - No distillation required
- Could easily supply all CA natural gas vehicles
 - 14.6 billion cu ft. potential



Sweden Biomethane Industry

World leader in fuel production

- Nearly two dozen biogas plants
- Over 30 biogas refueling stations
- >7000+ NG bi-fuel vehicles
- Potential to meet 20% of transportation demand



CA is Collaborating with Sweden

- To create a new fuel supply system
 - No biomethane infrastructure in CA
- Central Valley site with trucks & biogas
- Looking for funding for upgrading plant
- EPA providing ~half million \$ in funding for facility & truck conversions



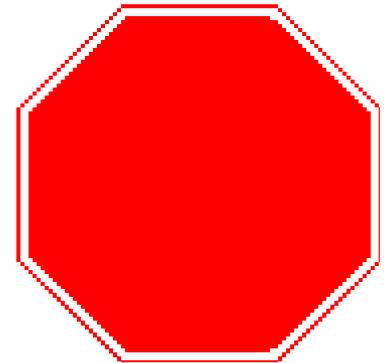
Biomethane for Power Plants

- PG&E has signed contracts to buy
- SCE also has negotiated purchase
- Other utilities in U.S. watching CA
- Success depends on
 - Dairy location near pipeline
 - Price of Natural Gas
 - Environmental regulatory req.



Obstacles to New Digesters Facilities

- Regulations (State)
 - Up to two year delay in getting approval
 - CEQA required for offsite feedstocks
- Lack of funding for enhancement tech.
 - No State funding for biomethane upgrading
- Environmentalist
 - Either are silent or openly oppose digesters
 - Opposite of European experience



Conclusion

- Digesters are the most environmentally friendly renewable energy and fuel technology available
- There will always be trade-offs
 - Greenhouse Gas↓↓ air pollution↓ odors↓ NOx↑
- Need to overcome regulatory and other barriers
- Where do you stand on methane digesters?

