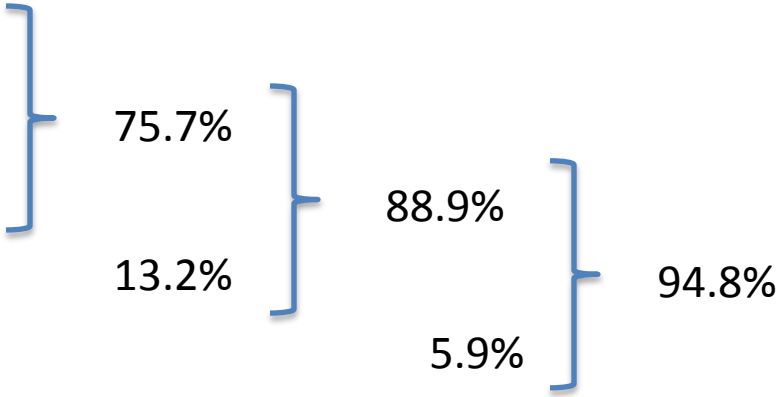
A Digester for the 125 Cow Dairy: Fact or Fiction?

M. Charles Gould
Extension Educator-Bioproducts and Bioenergy
Agriculture and Agribusiness Institute
Michigan State University

Midwest Manure Summit
Green Bay, WI
February 15-16, 2010

Dairy Farms in the United States (2009)

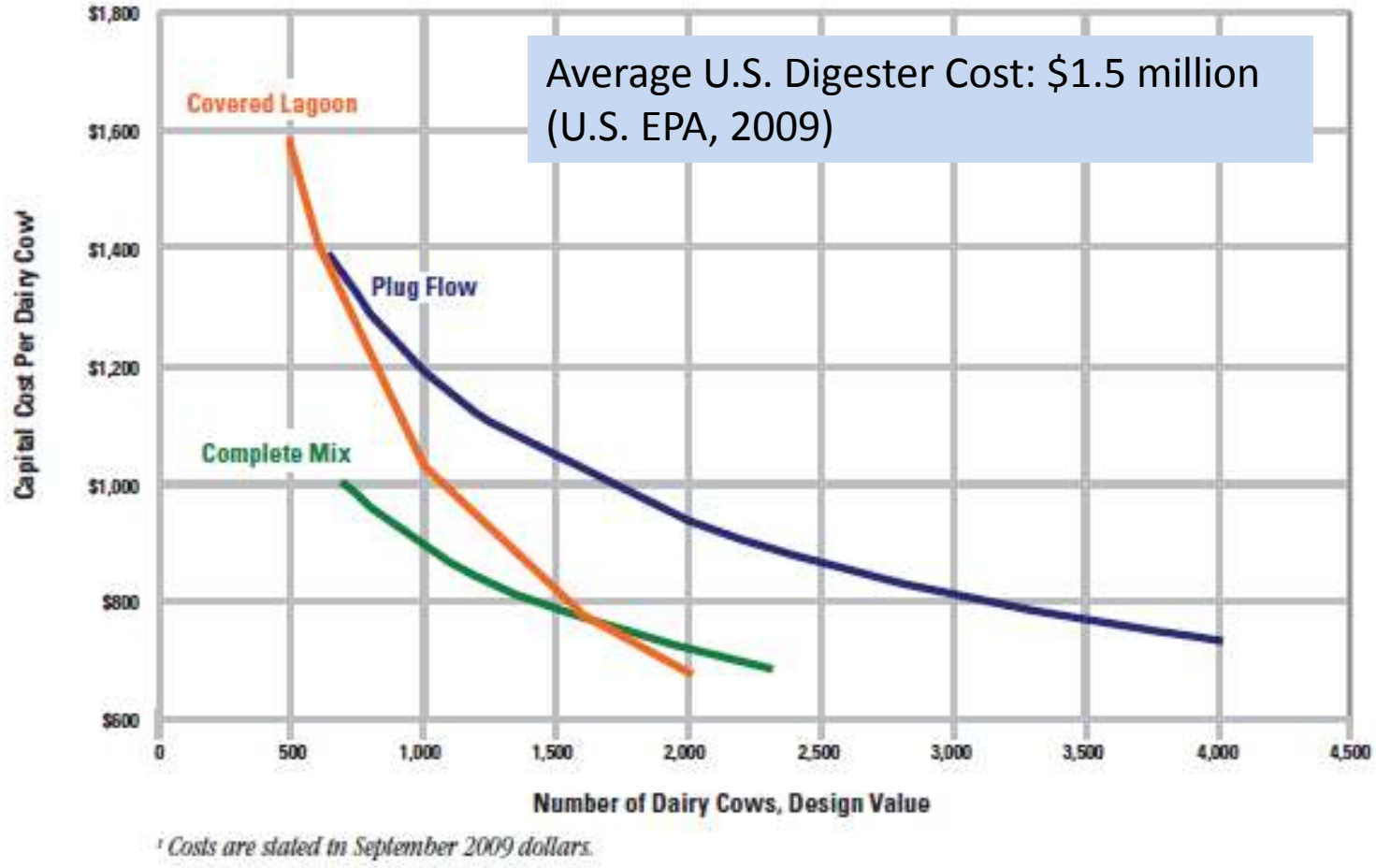
Herd Size (hd of cattle)	Number of Farms	Percent of Total Farms
1-29	20,400	31.4
30-49	11,500	17.7
50-99	17,300	26.6
100-199	8,600	13.2
200-499	3,850	5.9
500-999	1,700	2.6
1,000-1,999	910	1.4
2,000+	740	1.1
Total	**65,000**	**99.9**



61,650 farms <500 cows
94.8% of total farms

Adapted from: USDA, NASS Farms, Land in Farms and Livestock Operations

Low-cost, small-scale AD…not traditionally an option



Source: AgStar. 2010. *Anaerobic Digestion Capital Costs for Dairy Farms*.

The Situation

- Average dairy herd size in Michigan – 135 cows.
- Farmers with small dairies want the advantages of an anaerobic digester.
- Must be affordable and manageable.

Case Study - Jer-Lindy Farm (MN)

- Approximately 160 cows providing manure to digester[2]
- Induced blanket reactor (IBR) digester[1]
  - 33,000 gallon capacity
  - Operates at temperatures between 104-106˚ F
  - Manure input each day is about 7,000 gallons
  - Five day retention time
- Assumes 40 kw generator produces 430 kWh of electricity daily:[2]
  - 95 kWh is used to operate pumps, digester and separation equipment.
  - 335 kWh per day to replace electricity purchases or to sell back to the grid.
- Paying around 8.5 cents/kWh for electricity[2]
- Solids are removed using a FAN separator[1]

1. Greer, Diane. 2010. *Anaerobic Digestion For Smaller Dairies*. http://www.jgpress.com/archives/_free/002102.html
2. Lazarus, William F. 2008. *Economic Analysis of the Jer-Lindy Farms Anaerobic Digester*. www.mnproject.org.

Investment Required for the Digester System

Digester tank, gen-set and set up:	$267,000
Fan Separator:	$36,000
Building costs and concrete:	$33,000
Utility hook up:	$12,000
Flare and boiler:	$13,000
Total for above items:	**$361,000**

Plus the following site-specific items that will vary to a great extent from operation to operation:

Tank insulation:	$32,000
Labor:	$15,000
Additional plumbing and electrical work:	$20,000
Pump and agitator:	$22,000
Excavation:	$10,000
Total for above site-specific items:	**$99,000**
Total Digester Investment:	**$460,000**

Lazarus, William F. 2008. *Economic Analysis of the Jer-Lindy Farms Anaerobic Digester*. www.mnproject.org

Economic Analysis of the Jer-Lindy Farm Digester

Sources of Value		$/year	$/cow
Electricity generated (335 kwh/day x 365 x $0.085/kwh)		10,393	
Bedding ($75/cow)		12,000	
Reduced manure agitation and hauling		2,400	
MN Renewable Energy Production Incentive		1,834	
Carbon credits		556	
Total annual benefits		**$27,184**	
Project investment	$460,000		$2,875
Engine overhaul - every 4 years		1,250	
Other O&M (2% of investment?) and labor (0.3 hrs./day?)		11,390	
Depreciation & interest, 20 year life, 6%		29,453	
Total annual costs		**$42,093**	
Grant funds - covered 72% of the project	$329,900		$2,062
Project investment net of grants	$130,100		$813
Annualized value of grants amortized over 20 year life		16,495	
Total annual costs net of grants		**$25,598**	
Net return/year over operating and ownership costs		**$1,586**	
Years to payback		**11 years**	

Lazarus, William F. 2008. *Economic Analysis of the Jer-Lindy Farms Anaerobic Digester*. www.mnproject.org

Potential Solutions

- Systems approach
- Change policy
- Increase digester efficiencies
- Redefine priorities

Systems Approach

- The *Native*Energy Concept
  - Cost-efficient digester volume
  - Multi-site cluster development
    - Design, permitting, financing, procurement, construction, commissioning and operation
  - Design-Build-Own-Operate-Transfer Transaction Structure
  - For more information, contact *Native*Energy, Inc. www.nativeenergy.com

Policy Change: Increase CO_2 Prices

- A recent study tried to identify carbon prices that would make digesters profitable on dairy farms across the U.S. of different sizes concluded that:
  - The breakeven CO_2 prices required for digester profitability vary quite widely with farm size and state
  - A higher carbon price would give larger farms more of a milk production cost advantage than they have currently

Source: Lazarus, W.F. et al. 2010. *Carbon Prices Required to Make Digesters Profitable on U.S. Dairy Farms of Different Sizes*

Table 8. Minimum Breakeven CO_2 Price Required for Farms to Install Digesters, by State and Herd Size, $/Metric Tonne

	100 to 199 Cows	200 to 499	500 to 999	1,000 to 2,499	2,500 or more
California	$44.89	$22.14	$13.14	$10.01	$5.51
Idaho	43.15	20.08	11.13	8.60	4.33
Michigan	47.35	24.72	13.14	7.12	3.70
Minnesota	55.36	28.19	15.27	11.64	5.67
New Mexico	45.47	17.30	11.18	6.59	3.36
New York	52.84	25.83	10.85	3.53	0.00
Pennsylvania	54.72	27.91	15.16	8.99	3.42
Texas	44.38	23.05	12.40	4.61	0.64
Washington	39.67	19.77	11.39	8.64	4.39
Wisconsin	53.94	26.94	14.85	10.26	5.15

Source: Lazarus, W.F. et al. 2010. *Carbon Prices Required to Make Digesters Profitable on U.S. Dairy Farms of Different Sizes*

Table 9. Change in Cost of Producing Milk Due to Two CO2 Prices, for Farms Currently Using Lagoons for Manure Handling, by State and Herd Size, $ Per 100 kilograms[a]

State	100 to 199	200 to 499	500 to 999	1,000 to 2,499	2,500 or more
		--- CO_2 priced at $20 per mt ---			
California	***$0.00***	***$0.00***	-$0.37	-$0.61	-$0.92
Idaho	***0.00***	***0.00***	-0.55	-0.80	-1.14
Michigan	***0.00***	***0.00***	-0.38	-0.83	-1.05
Minnesota	***0.00***	***0.00***	-0.27	-0.51	-0.97
New Mexico	***0.00***	-0.16	-0.52	-0.91	-1.13
New York	***0.00***	***0.00***	-0.60	-1.08	-1.42
Pennsylvania	***0.00***	***0.00***	-0.28	-0.74	-1.12
Texas	***0.00***	***0.00***	-0.55	-1.11	-1.39
Washington	***0.00***	-0.01	-0.52	-0.80	-1.11
Wisconsin	***0.00***	***0.00***	-0.29	-0.65	-0.99
		--- CO2 priced at $40 per mt ---			
California	***$0.00***	-$0.97	-$1.45	-$1.88	-$2.19
Idaho	***0.00***	-1.24	-1.85	-2.25	-2.59
Michigan	***0.00***	-0.84	-1.62	-2.11	-2.33
Minnesota	***0.00***	-0.68	-1.43	-1.86	-2.32
New Mexico	***0.00***	-1.32	-1.87	-2.27	-2.49
New York	***0.00***	-0.79	-1.90	-2.38	-2.73
Pennsylvania	***0.00***	-0.70	-1.52	-2.10	-2.47
Texas	***0.00***	-1.04	-1.98	-2.54	-2.83
Washington	-0.02	-1.23	-1.80	-2.22	-2.53
Wisconsin	***0.00***	-0.74	-1.43	-1.98	-2.32

[a]States and herd sizes NOT installing digesters are underlined and in italics. These cost reductions compare to a U.S. average cost of $50 per 100 kilograms ($22.73 per 100 pounds) in 2009.

Source: Lazarus, W.F. et al. 2010. *Carbon Prices Required to Make Digesters Profitable on U.S. Dairy Farms of Different Sizes*

Increase Digester Efficiencies

- Digester design
  - Reduce HRT
  - Modular components
- Cheaper digester vessels
  - Use materials other than concrete and steel
    - Example: geo-membrane covered, insulated and heated in-ground digester
- Improve digester performance
  - Manipulate methanogenesis?
  - Methanogens that are more efficient at producing methane?

Redefine Reasons for Installing a Digester

- Odor control, nutrient management, reduced emissions, and producing enough electricity to power the farm
- A digester allows a dairy to become a bio-refinery, producing marketable products and utilizing heat energy

Additional Solutions

- Recognize market
  - Small-scale farms and waste generators constitute a large market
- Scale up, not down
  - Engineering based on viable small-scale designs
- Focus on biogas as end-product
  - Heating, cooking, refrigeration
- Explore digestion options
  - Co-digestion of food waste

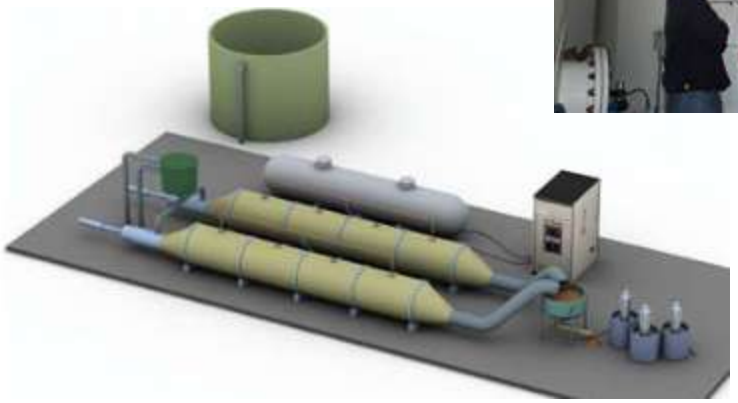
Source: Lansing. S and Moss A.R. 2010. Small-Scale Anaerobic Digestion: Technology and Applications presentation.

Additional Points to Consider…

- Published digester economic assessments tend to show that the most successful digesters are those that have:
  - Generated added value from separated manure fiber.
  - Charged tipping fees for accepting off-farm food processing wastes.
  - Had a nearby high-value use for the biogas or electricity.
- Electricity sales alone are not usually enough to cover costs.
- Even an unprofitable digester may be regarded as successful if it provides nonmonetary benefits such as odor control.

Small Scale Digester Companies

- Avatar Energy (CA)
- Andigen (UT)
- USEMCO (WI)
- Pro-Act Biotech (RI)
- Environmental Fabrics, Inc. (SC)



Note: Mention of company names should not be construed to be an endorsement by MSU Extension.

MSU Anaerobic Digestion Research and Education Center

- The purpose of the Center is to assist Michigan State University researchers in developing technology for smaller farms to turn animal waste into usable heat, electricity, and other valuable products.
- The Center will consolidate new and existing programs in a planned 3,280-square-foot building south of campus, at MSU's expanding farm animal and environmental research complex.
- Received state and foundation grants exceeding $3 million to get the Center started.
- Dr. Dana Kirk is the Center's manager.

Anaerobic Digestion Research and Education Center

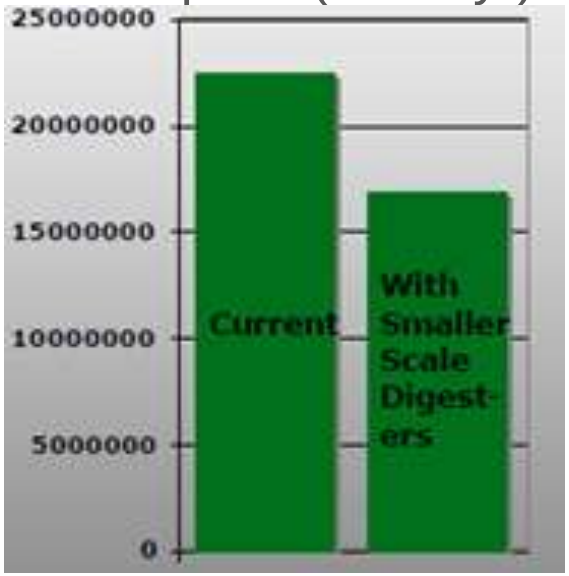
Michigan State University

Michigan On-Farm Digester Operator Certification Program

- The General Property Tax Act (P.A. 206 of 1893), as amended in 2006, gives property tax exemptions to farm owners of “methane digesters and methane electric generating equipment” who have on their payroll, anaerobic digester operators that are certified as “qualified” by the Michigan Department of Agriculture (MDA).
- To be qualified means that the operator possesses the skills necessary to start, maintain the operation of, and troubleshoot problems with an anaerobic digester.
- Those who desire certification must:
  - Attend a two-day educational program sponsored by MSU Extension.
  - Submit to an on-site digester operator performance evaluation conducted by MDA.
- Successful digester operator performance as determined by MDA must be verified each year in order to receive property tax exemption.

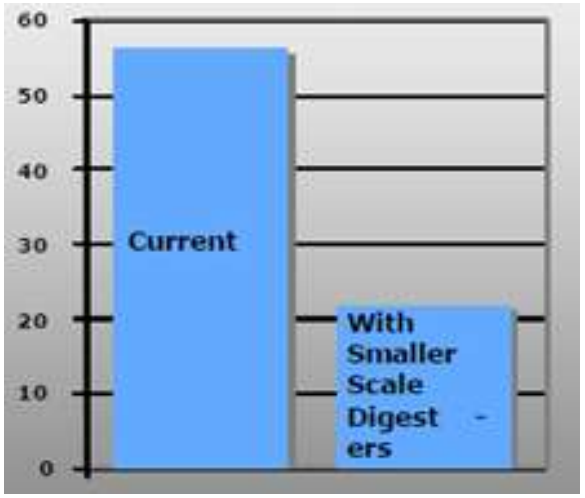
The Bioenergy Industry with Smaller-scale Digesters

US annual natural gas consumption (MMcf/yr)



US natural gas consumption reduced by 25% (equivalent to 1 billion barrels of oil annually)

MMt CH_4 emissions from livestock manure/yr



US methane emissions reduced by 5% per year (reduction of 34.5 million tons of CO_2 equivalent)

Source: Lansing. S and Moss A.R. 2010. Small-Scale Anaerobic Digestion: Technology and Applications presentation.

Conclusions

- Small dairies want the advantages of a digester
- Small dairies represent an untapped market for digester vendors
- Small dairies will still rely on grant funding to make digesters pay into the foreseeable future
- It’s going to take a combination of solutions to make digesters affordable for small dairies

M. Charles Gould

Extension Educator-Agricultural Bioenergy & Bioproducts and On-farm Energy Efficiency
Agriculture and Agribusiness Institute
Michigan State University

12220 Fillmore St, Suite 122
West Olive, MI 49460
Toll Free: 1-888-678-3464, Ext.O-T-T-A-W
Phone: (616) 994-4580
Fax: (616) 994-4579

MSU Bioeconomy Institute
242 Howard Street
Holland, MI 49424
616/395-8945

Thank you!

Michigan Manure Resources Network
http://web2.msue.msu.edu/manure

MSU Extension – Ottawa County
http://www.msue.msu.edu/portal/default.cfm?pageset_id=28508