Economics of Biogas Digesters

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Potential Sources of Value from a Digester

- **Energy**
- **Odor Control**
- **Methane (Greenhouse Gas) Destruction**
- **Reduction in Pathogens and Oxygen Demand**

(If coupled with solids separation equipment)

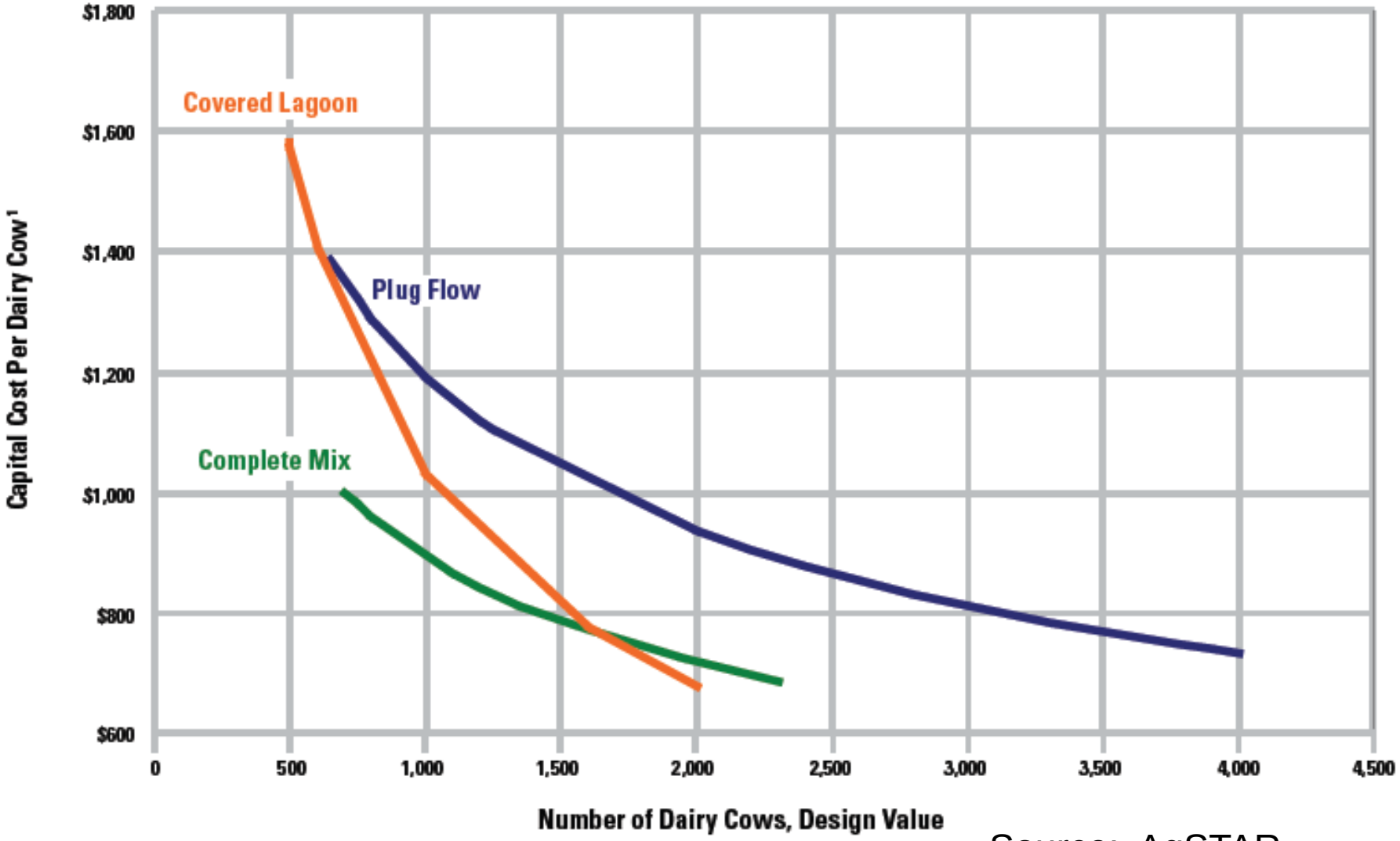
- ***Solids (Fiber) for Bedding, as a Soil Amendment, or for Energy***
- ***Phosphorus and Nitrogen Reduction***

Factors Likely to Improve the Economics

- Large system for capital efficiency and to justify technology and management
  - Six-tenths rule –

    $\text{Cost } \$_2 = \text{Cost } \$_1 \, (\text{Capacity}_2/\text{Capacity}_1)^{(0.667)}$
- Opportunity to replace energy purchases at retail prices
- Carbon credits, RECs & other incentives
- Co-digestion of off-farm wastes for increased gas output and tipping fees

Figure 1. Total capital cost of complete mix, plug flow, and covered lagoon AD systems



[1] *Costs are stated in September 2009 dollars.*

Source: AgSTAR

Figure 2. Capital cost per dairy cow for complete mix, plug flow, and covered lagoon AD systems

Assumptions for Economic Scenarios

Investment Requirement:

Investment requirement at two example farm sizes:

700 cows -	$1.1 million	$1,571/cow
1,400 cows -	$1.6 million	$1,143/cow

Based on $645,581 + $703/dairy cow from 19 plug-flow digesters

Utility connection charges and H2S treatment could add up to 20%

Capital cost (6%, 20 year life): 9% of investment/year

Operation and maintenance costs: 5% of investment/year?

Electricity output: 1,150 KWH/cow/year

Sources: Investment equation from Crenshaw, electricity output from Gooch.

Economic Scenarios

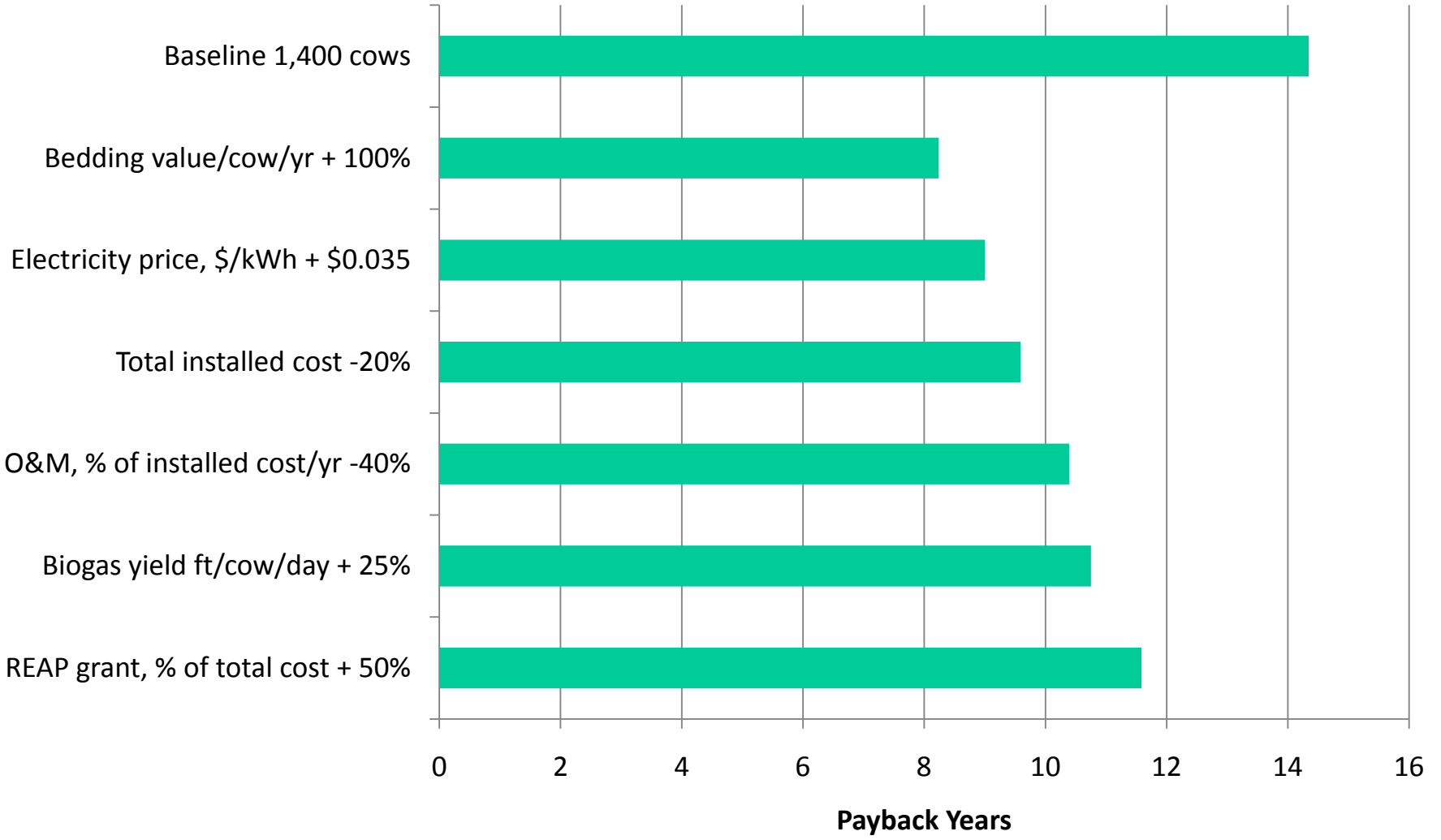
	700 cows	1,400 cows
Investment	$1.1 million	$1.6 million
Electricity breakeven prices (cents/kWh)		
• No subsidies or other value	19 cents	14 cents
• REAP 25%, 1.5-ct/kWh MN	15	11
• Grant & bedding value $50/cow	11	6

Electricity market

- Retail price (EIA, 1/11): U.S. average 10 cents, MN 8 cents
  range 6 cents (WY) to 17 cents (CT)
- Generation cost (my estimates): U.S. avg 5 cents, MN 4 cents
  range 2 cents (ND) to 11 cents (CT)

Value of odor control, carbon credits, RECs, pathogen reduction, other??

1,400-Cow Farm, 3.5-7 cent Electricity, $50/cow Bedding Value, 25% REAP, 1.5-cent/kWh MN credit, 5% O&M Cost



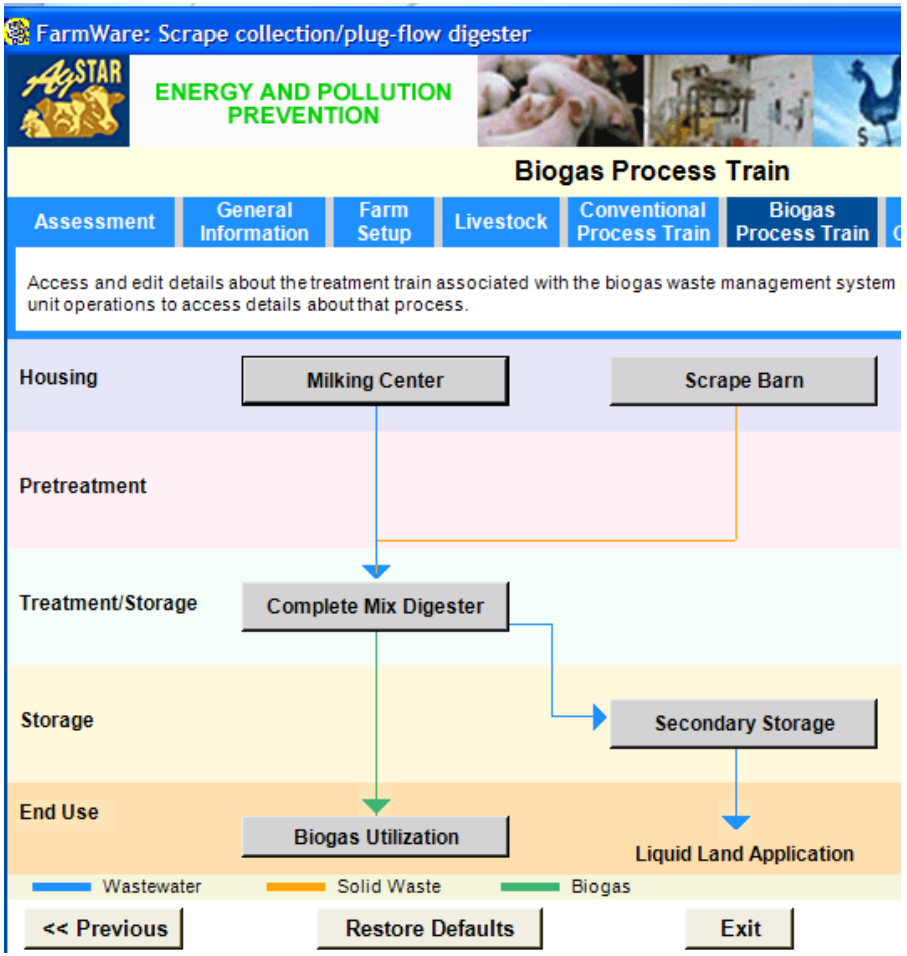
Other Considerations

- How to size the system to allow for future dairy herd growth or co-digestion?
- How much redundancy do you design into your engine-generation sets?
- What is manure solids bedding worth?
- How can you market and generate value from the extra solids you don’t need for bedding?
- Will the AD system improve the fertilizer value of the manure? Would separation equipment alone be enough to achieve this improvement?

Computer Decision Tools for Analyzing Economic Payback

	A	B	C	D
1	**"Anaerobic Digester Economics" Spreadsheet**			
3	UNIVERSITY OF MINNESOTA EXTENSION		by William F. Lazarus, Extension Economist	
4			Last modified on 9/3/09	
5		About the Spreadsheet -	Display More Scenarios	
6				
9	Inputs:			
10	Scenario description:		Suggested values	Baseline
11	**Herd size, lactating dairy cows:**	head	500 minimum	2,000
12	**Methane and electricity generation:**			
13	**Gas Production Assumptions -- Manure:**			
14	Manure volatile solids from the lactating dairy cows	lbs/cow/day	7-17	12.6
15	Biogas converted from volatile solids	ft3/lb VS	6.3	6.3
16	Expected biogas yield	ft3/cow/day	25-135	79
17	Energy content of biogas	BTU/ft3	550-700	600
18	Energy converted	BTU/cow/day		11,907
	Help on other waste streams and generator size			
19	**Gas Production Assumptions -- Other Waste Streams:**			
20	Tons per day			-
28	**Electrical Conversion Assumptions:**			
29	Energy conversion constant	BTUs per kWh	3,412	3,412
30	Engine thermal conversion efficiency	%	23-28%	25%
31	Engine daily online percent	%	70-100%	90%
32	Electricity generated if all biogas is converted	kwh/cow/day		3.14
33	Farm total per year	kwh/year		2,294,331
34	Generator size that biogas BTU would power	kw		291
35	Generator size planned	kw		290

http://z.umn.edu/digester



http://www.epa.gov/agstar/resources/handbook.html

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

Thank you!

Questions?

LINK TO SPREADSHEET: http://z.umn.edu/digester