Economics of Digester Integration into an Energy/Nutrient Management System and Cogeneration

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Virtual Field Day on Anaerobic Digesters as a Tool for Energy Production, Manure/Nutrient Management and Revenue Generation
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WHAT IS THE VALUE OF A DIGESTER IN AN INTEGRATED DIGESTER/NUTRIENT MANAGEMENT SYSTEM?

- Most digesters generate electricity, but electricity generally doesn’t cover costs.
- Increasing interest in integrated digester/nutrient management systems.
  - There are also many dairy farms with only separators without digesters.
- Do tighter nutrient regulations call for high-efficiency separators that require a lot of energy – making digesters more valuable?
HOW MUCH DOES A DIGESTER COST TO INSTALL?

![Graph showing capital cost per dairy cow for different AD systems.

Source: AgSTAR data, 40 digesters

1 Costs are stated in September 2009 dollars.

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

Source: AgSTAR data, 40 digesters
**ASSUMPTIONS FOR ECONOMIC SCENARIOS**

**Investment Requirement:**

Investment requirement at two example farm sizes:

- 1,400 cows - $1.3 million $929/cow
- 2,800 cows - $2.3 million $821/cow

Based on $320,864 + $563/dairy cow from 13 complete-mix digesters, with utility connection charges, H2S treatment, and inflation adjustment.

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

**Operation and maintenance costs:** 3% of investment/year

**Electricity output:** 1,041 kWh/cow/year less 50 kWh/cow/year to operate

**Carbon price:** $7/metric tonne
# ECONOMIC SCENARIOS

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<th>1,400 cows</th>
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<td><strong>Investment</strong></td>
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**Electricity breakeven prices (cents/kWh)**
- No subsidies or other value: 11.0 cents, 9.7 cents
- REAP 25%: 8.9, 7.9

**Electricity market**
- Retail price (EIA, 1/11): U.S. average 9.8 cents, NM 8.1 cents
  range 6 cents (WY) to 17 cents (CT)

*Price for excess electricity sold back to grid?*

*Value of manure solids, odor control, RECs, other??*
2,800-Cow Farm, 6-cent Electricity, 25% REAP, 3% O&M, $7 Carbon Price

- Baseline 2,800 cows
- Elec. price + 50%
- Total installed cost -20%
- Biogas yield/cow + 25%
- REAP grant, % of total cost + 50%
- O&M, % of installed cost/yr -40%
- Carbon price + 50%

Payback Years

0 2 4 6 8 10 12 14
IDEAS FOR FUTURE RESEARCH

- AgSTAR database of operating digesters is great, but I wish I knew more about their nutrient management components, nutrient limits or trading as a motivating factor, and solids utilization.

- Economics of compressing biogas for transportation fuel, or injecting it into the natural gas grid?

- Other …
MY SPREADSHEET FOR ANALYZING DIGESTER ECONOMICS

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<td>&quot;Anaerobic Digester Economics&quot; Spreadsheet</td>
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### Inputs:

**Scenario description:**
- Suggested values: Baseline 2,800 cows
- **Herd size, lactating dairy cows:** head

### Methane and electricity generation:

#### Gas Production Assumptions -- Manure:

- **Expected biogas yield:** ft³/cow/day 25-90
- **Energy content of biogas:** BTU/ft³ 550-700
- **Energy converted:** BTU/cow/day 10,800

#### Electrical Conversion Assumptions:

- **Energy conversion constant:** BTUs per kWh 3,412
- **Engine thermal conversion efficiency:** % 23-28%
- **Engine daily online percent:** % 70-100%
- **Electricity generated if all biogas is converted:** kwh/cow/year 1,041
- **Ferm total per year:** kwh/year 2,913,436
- **Generator size that biogas BTU would power:** kw 369
- **Generator size planned:** kw 369

### Other:

- [http://z.umn.edu/digester](http://z.umn.edu/digester)
Thank you.

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