

# Economic Fundamentals of Dairy Farm Digestion Systems

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# Overview

- Review of several economic studies and their conclusions
- Identify primary economic drivers and opportunity areas for digester projects

# Big 5 Results – (Gooch/Wright et al., 2004)



# Big 5 Capital Costs

|                 | AA      | DDI     | NH      | ML      | FA      |
|-----------------|---------|---------|---------|---------|---------|
| # of cows       | 500     | 850     | 1100    | 740     | 100     |
| Digester Set    | 192,000 | 442,200 | 339,400 | 298,149 | 80,183  |
| Separator Set   | 50,000  | 89,000  | 61,000  | 61,689  | 44,013  |
| Gas Utilization | 61,000  | 138,200 | 287,300 | 130,431 | 13,135  |
| Total Cap. Cost | 303,000 | 669,400 | 687,700 | 490,269 | 137,331 |
| Cap. Cost/Cow   | 606     | 788     | 625     | 663     | 1,373   |

Note: Digesters completed between 1997 and 2002

# Big 5 Annual Operating Costs

|                                     | AA           | DDI          | NH            | ML           | FA            |
|-------------------------------------|--------------|--------------|---------------|--------------|---------------|
| # of cows                           | 500          | 850          | 1100          | 740          | 100           |
| Projected Capital Costs (per cow)   | 25,468<br>51 | 52,978<br>62 | 63,274<br>58  | 49,016<br>66 | 13,396<br>134 |
| Estimated Operating Costs (per cow) | 12,072<br>24 | 26,339<br>31 | 40,686<br>37  | 21,864<br>30 | 8,101<br>81   |
| % of CapEx                          | 4.0%         | 4.0%         | 5.9%          | 4.4%         | 5.9%          |
| Tot Estimated Annual Cost (per cow) | 37,540<br>75 | 79,317<br>93 | 103,960<br>95 | 70,880<br>96 | 21,497<br>215 |

Note: Annual capital costs = foregone interest (5%) + depreciation

# Big 5 Revenues and Net Income

|   | AA            | DDI            | NH             | ML             | FA              |
|---|---------------|----------------|----------------|----------------|-----------------|
| # of cows                                       | 500           | 850            | 1100           | 740            | 100             |
| Tot Est. Annual Revenue<br>(per cow)            | 56,445<br>113 | 60,400<br>71   | 77,680<br>71   | 287,685<br>389 | 10,900<br>109   |
| Tot Est. Annual Cost or<br>Benefit<br>(per cow) | 18,906<br>38  | -18,917<br>-22 | -26,280<br>-24 | 216,805<br>293 | -10,597<br>-106 |

Note: revenue from farm electrical savings (non-parasitic), electric sales, use of heat (hot water), tipping fees, and compost sales.

# Big 5 Summary

- Capital costs for largest systems ~700k (expect to pay more now for same systems due to inflation and increase in building material costs)
- Near break-even net income for heat and power use & sales (through net metering)
- Co-digestion has a significant impact on revenue and net income

# University of Nebraska Study

(Stowell, R. and Henry, C., 2004)

- Modeled different economic scenarios for 100, 500, and 1000-cow dairy farms
- Capital costs estimated from FarmWare™
- Considered use of:
  - No interest loan for capital
  - Grant for 20% of capital costs
  - Tax credits of \$0.001 and \$0.01 kWh
  - Excess electricity sales at \$0.02 & \$0.04/kWh



# Modeled Return on Investment

| Incentive                 | Resulting Net Present Value |           |           |
|---------------------------|-----------------------------|-----------|-----------|
|                           | 100 cows                    | 500 cows  | 1000 cows |
| No Policy (control)       | -\$42,000                   | -\$42,000 | -\$45,000 |
| No-interest loan          | -\$28,000                   | -\$14,000 | -\$3,000  |
| 20% Capital Grant         | -\$30,000                   | -\$18,000 | -\$9,000  |
| \$0.001/kWh tax credit    | -\$42,000                   | -\$39,000 | -\$40,000 |
| \$0.01/kWh tax credit     | -\$37,000                   | -\$14,000 | \$10,000  |
| \$0.02/kWh electric sales | N/A                         | -\$34,000 | -\$21,000 |
| \$0.04/kWh electric sales | N/A                         | -\$25,000 | \$3,000   |

# Summary of Nebraska Findings:

- Small farms benefit most from capital cost reductions and low interest loans
- Large farms benefit most from tax credits and good prices for sales of excess energy

# Haubenschild Study

(Goodrich and Schmidt, 2002)



- 800-cow dairy w/ plug flow digester
- 85 cfd biogas/cow production rate
- 150 kW gen set, 95% run time, average power needs = 1,500 Kwh/day,

# Haubenschild Study, Cont.

- Total capital costs = \$360,000 (1999)
- Estimated O&M = \$17,167 (4.8% of cap)
- Annual revenue = \$66.2k (450 cows) to \$85,000 with 750 cows (\$81,000 in electric sales at \$0.0725/kWh + \$4,000 in propane savings)
- Payback at 10% interest = 5 – 7 years (for 10-year mortgage for \$355k)

# Summary of Findings:

Favorable economic projections based on:

1. Well-managed system (85 cfd biogas/cow + 95% gen run time)
2. Competitive capital costs (~\$360k)
3. \$0.073/kWh power prices for all power produced (PPA with local electric cooperative)

# Ag Innovation Center Projections

- Pro-forma estimations (available through the Cornell manure management website)
- Case Study evaluation (2004/2005):
  - ~ 1000+ cow dairy facility
    - Total digester system = \$1,040,000
    - 40% capital grants, 10% equity, 3 loans
    - Annual operating costs = \$41,000 (4% cap) not including principal payments

# AIC Projections, cont.

- Total Projected Revenue = \$157,000/year
  - Net metering at \$0.12/kWh offset, \$0.05/kWh for excess electric sales
  - Bedding using dig. solids (\$55,000 per year)
- Net Income = \$67,000 (year 2)
- Net Cash Flow = \$61,000 (year 2)
- Simple payback = 9.3 years (with grants)

# AIC Project Financial Viability Based On:

- Grant \$ to reduce capital layout
- Relatively high electric rates
- Use of digested solids as bedding





# Summary Thoughts:

How Can We Improve Economic Performance of these systems?

1. Increase project system performance and revenues
2. Reduce capital costs or impacts

# Revenue Improvement:

- Co-Digestion of organic substrates
  - Tipping fees
  - Additional biogas production
- Make use of heat and/or biogas on-site
- Use of digested separated solids
- Increase value of excess energy sold to the grid (green energy pricing/RPS)
- Sale of renewable energy credits

# Examples of Improved Revenue

- 160 kW output for Dairy with 1000 cows:
- 93% run time (down 25.5 days/year) = 1,303,000 kWh per year
- Estimated yearly energy consumption = 803,000 kWh per year (w/ parasitic)
- Excess energy = 500,000 kW hours

# Value of Excess 500,000 kWh of Power Sold to Grid

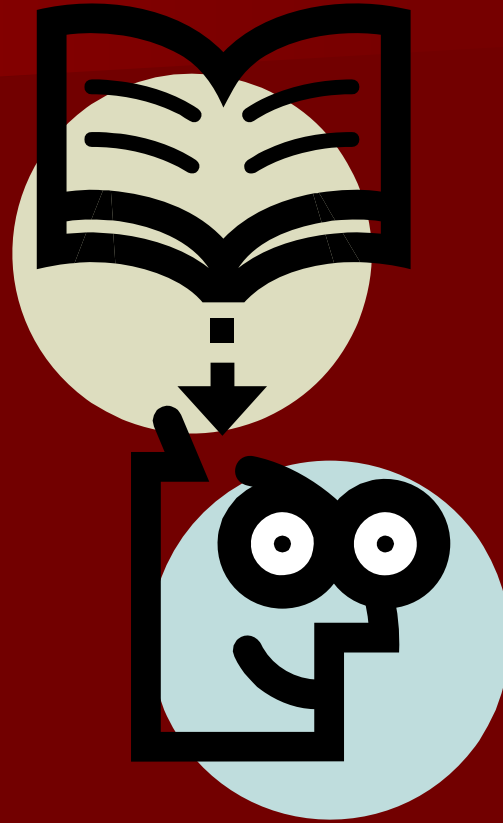
|             |          |          |          |          |          |
|-------------|----------|----------|----------|----------|----------|
| Power Price | \$0.04   | \$0.05   | \$0.073  | \$0.10   | \$0.12   |
| Revenue     | \$20,000 | \$25,000 | \$36,500 | \$50,000 | \$60,000 |

# Capital Cost/Impact Improvement

- Improve digester designs (R&D)
- Grants to reduce debt payment impact
- Example of payment reductions (15yr/7.25%)

| Capital Reduction           | \$100,000         | \$200,000           | \$300,000           | \$500,000           |
|-----------------------------|-------------------|---------------------|---------------------|---------------------|
| Payment Reduction (monthly) | \$11,153<br>\$929 | \$22,307<br>\$1,859 | \$33,460<br>\$2,788 | \$55,767<br>\$4,647 |

# For More Information



■ [www.manuremanagement.cornell.edu](http://www.manuremanagement.cornell.edu)