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The Economic Impacts of Various Public-Policy Scenarios for Methane Recovery on Dairy Farms

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Abstract.

The feasibility of anaerobic digesters for dairy and swine operations in Nebraska was evaluated using EPA's Ag Star software program Farmworks 2.0 (1997) and local values for farm energy costs, mainly electricity. Four incentive programs were considered that would subsidize anaerobic digestion. Installation of a digester system is a significant investment that is currently very difficult to justify economically to Nebraska producers based upon consideration of readily quantifiable income and expenses, regardless of farm size. Larger dairy operations looking to invest in this technology would benefit most from a tax credit and/or subsidized electricity sales, policies that relate directly to the production of electricity. On the other hand, small dairy farms likely would benefit more from a no-interest loan or a cost-share program – policies that relate directly to the capital cost incurred. Larger operations are more likely to place a value on odor control and would experience a lower unitized effective cost than smaller operations. The effective cost may still be unwieldy in an industry with tight profit margins, however.

Keywords. Methane recovery, anaerobic digesters, economic, subsidies, incentives

Introduction

Methane recovery is often promoted as a renewable energy resource and as a means of managing manure solids and controlling odors on livestock farms. With or without electricity generation, however, methane recovery is generally not expected to be a profitable venture for most operations in Nebraska. To better understand the costs incurred and the likely impact of public policy decisions on the feasibility of anaerobic digesters, economic analyses were performed on anaerobic digestion of manure from dairy farms and swine finishing operations. This paper focuses on the results for the dairy operations. The main factors considered were herd size (100 head; 500 head; and 1,000 head) and method of financial support provided (cost-share program, no-interest loans, tax subsidies, and subsidized electrical sales).

Analysis of Anaerobic Digesters in Nebraska

EPA's Ag Star software program Farmworks 2.0 (1997) was used to evaluate the feasibility of anaerobic digesters in Nebraska. Local values for farm energy costs, propane usage, etc. were obtained to more closely represent Nebraska conditions. Then, incentive programs were considered that would subsidize anaerobic digestion. First, we considered the use of a no-interest loan for capital purchases. Second, we evaluated a cost-share program that would subsidize 20% of the capital cost of installing a digester. Third, tax credits of 1/10 ¢ and 1 ¢ per kWh generated were considered. Wind power sources currently receive a 1.7 ¢ per kWh federal tax credit (Wiser, et. al., 2001). Finally, we considered the sale of excess generated electricity to the utility for 2 ¢ per kWh (approximate utility production cost) and 4 ¢ per kWh (twice the expected utility production cost).

In our analysis, we considered what type of dairy farm would most likely utilize this technology. Dairy operations with confined housing for the cattle, a scrape system for manure collection, and organic bedding would lend themselves best to use of a plug-flow digester. Systems having very diluted manure (flushing, treatment lagoons, runoff collection ponds, etc.), solid manure (bedded pack, separated solids, etc.), or potential sediments (e.g. sand bedding) do not lend themselves well to controlled anaerobic digestion and were not evaluated.

We also evaluated the relationship between size of operation and feasibility to determine the impact of farm scale. For this evaluation, 100 head; 500-head; and 1,000-head dairy operations were considered.

The impacts of the policy/pricing scenarios on economic return were modeled for the types and sizes of operations described. The control scenario in each case assumed the following:

- 20% down-payment made on capital investment
- Remainder financed at 8% on a 10-year loan
- Discount rate for farm capital = 10%
- Straight-line depreciation and 35% tax rate
- Operating and maintenance costs = 1.5%/year
- Electricity purchase price (retail price paid to utility) = 6 ¢ / kWh
- Excess electricity not valued (distributed to neighbor or returned to utility free of charge)

The first five assumptions were based upon general values used in similar types of evaluations. Note that we believe the 1.5% annual charge for operation and maintenance to be low, especially for smaller operations, but could not find any hard data to suggest a more appropriate

value. Using limited data from systems installed in the 70's and 80's would not accurately reflect improvements implemented since then. The other assumptions were based upon discussions with local livestock producers and utility representatives.

The following additional assumptions were used for dairy operations:

- Facility designed for milking herd only
- Plug-flow system
- Scrape system and organic bedding

Table 1 shows the capital costs for the construction of a plug-flow digester for the three size scenarios. Capital costs include: digester construction, engineering costs, engine generator, solid separator and mix tank. Excess electricity refers to electricity that cannot be used by the dairy and would be either given or sold back to the utility. The break-even price represents the price charged by the utility at which the technology may be feasible without any policy changes.

Table 1. Modeled annual electricity production and base cost of power generation on dairy farms.

	Number of milking animals		
	100 cows	500 cows	1,000 cows
Capital cost	\$98,000	\$190,000	\$296,000
Max. electric output	102,000 kWh	460,000 kWh	921,000 kWh
Excess electricity	0 kWh	69,000 kWh	102,000 kWh
Break-even electric cost	18 ¢ / kWh	9 ¢ / kWh	8 ¢ / kWh

The modeled capital cost of a digester and a system for electricity generation ranged from roughly \$98,000 to \$296,000 or from \$980 to \$296 per head. These costs should be considered baseline values for a bare-bones system. Cost figures from recent farm installations indicate that total start-up costs are likely to exceed these values. Unfortunately, there aren't enough installations in place to provide more accurate values. The bottom line was that the break-even electric price at the largest herd size (8 ¢ / kWh) exceeds what most producers are paying in Nebraska (closer to 6-7 ¢ / kWh).

Some operations are fixed consumers of electricity (e.g. water heating and vacuum demands during cleaning of a milking system). As a result, smaller farms consume proportionately more energy per head, and little if any excess (saleable) electricity generation should be expected. Dairy farms commonly benefit more than other livestock enterprises from generating their own electricity because they have comparatively high demands for electricity, and farm-generated electricity decreases their demand for purchase of electricity from the utility. Where facilities and operations are not high consumers of electricity, such as naturally ventilated buildings, the technology is not as attractive.

The net present value, simple payback and internal rate of return for the three direct-subsidy scenarios are shown in Table 2. Net present value (NPV) is the current value of all expected cash inflows and outflows of a project at a given discount rate over the life of the project. Simple payback is the number of years it takes to pay back the capital cost of a project calculated without discounting future revenues or costs. Internal rate of return (IRR) is the discount rate of return which makes the NPV of an income stream equal to zero (Roos and Moser, 1997). Since the livestock producer is assuming risk with this investment, an economically good investment will have a positive NPV and an internal rate of return that

exceeds the farm's discount rate (10% assumed). Some farm operators like to see a short payback period, such as less than 5 or 10 years, while for others, an internal rate of return greater than zero or close to the loan rate is acceptable for facilities that are not expected to be primary profit centers.

Without some form of subsidy or incentive, a positive net present value or rate of return would not be projected for any of the modeled herd sizes. This indicates that methane-fueled electricity generation is not expected to be a profit center on Nebraska livestock operations and confirms the previous findings that the break-even electric price is greater than that currently charged. For 1,000 cows, the payback period was approximately 10 years, which might be viewed as acceptable by some for long-term investments that may help maintain socio-environmental acceptance.

Also shown in Table 2 are scenarios where the dairy could sell back to the utility unused electricity. Utilities in Nebraska are generating electricity for approximately \$0.02/kWh, so there is currently little incentive to them to pay more than that to purchase electrical power.

For dairy operations with 1,000 or more cows, the opportunities to obtain a 1.0 ¢ / kWh tax credit and sell excess electricity for 4 ¢ / kWh showed the greatest advantage, being the only two modeled scenarios showing a projected profit on the investment. Whereas, for the 100-cow operations, greater economic benefits were derived from the no-interest loan and 20% cost-share subsidies, with the understanding that the benefit obtained was a reduction in expected loss on the investment.

Table 2. Modeled return on investment from electric power generation for several policy/price scenarios (as a function of size of milking herd).

Scenario	Net present value (x \$1,000)			Simple payback (years)			Internal rate of return (%)		
	100	500	1,000	100	500	1,000	100	500	1,000
No policy (control)	-42	-42	-45	19.7	9.2	7.9	< 0	< 0	< 0
No-interest loan	-28	-14	-3	19.7	9.2	7.9	< 0	< 0	9
Cost-share = 20%	-30	-18	-9	15.8	7.4	6.3	< 0	< 0	3
Tax credit									
0.1 ¢ / kWh	-42	-39	-40	19.7	9.2	7.9	< 0	< 0	< 0
1.0 ¢ / kWh	-37	-14	10	19.7	9.2	7.9	< 0	< 0	15
Sell electricity									
2 ¢ / kWh	NA*	-34	-21	NA	9.2	7.9	NA	< 0	< 0
4 ¢ / kWh	NA	-25	3	NA	9.2	7.9	NA	< 0	11

*There is no excess electricity expected for this size operation.

The effective cost of recovering methane only for the purpose of controlling odor is shown in Table 3. Effective cost is presented as the numerical portion of the net present value of the investment (generally negative). In these scenarios, the cost of the engine generator set was excluded and electricity generation capacity was set to zero. We assumed that excess biogas was burned off using flares. The benefit of a no-interest loan and a cost share program are shown compared to the current situation where there is no assistance available. The total cost of the system is shown as well as the cost per head. The application of a digester solely for the purpose of odor control was projected to have an effective cost off \$95 to \$470 per cow depending on herd size and subsidy available.

Table 3. Effective cost (NPV) of methane recovery from dairy operations for odor control (no electricity generation).

Scenario	Number of milking animals					
	100 cows		500 cows		1,000 cows	
No policy (control)	\$47,000	\$470/hd	\$88,000	\$176/hd	\$111,000	\$111/hd
No-interest loan	\$37,000	\$370/hd	\$72,000	\$144/hd	\$92,000	\$92/hd
Cost-share = 20%	\$39,000	\$390/hd	\$74,000	\$148/hd	\$95,000	\$95/hd

Summary and Conclusions

Installation of a digester system is a significant investment. It is also an investment that is currently very difficult to justify economically to Nebraska dairy producers based upon consideration of readily quantifiable income and expenses, regardless of farm size. Our projections showed that methane digestion with cogeneration would not be expected to be a profitable venture for any of the farm sizes considered without some form of subsidy or other incentive, and small operations would be hard-pressed to profit from the investment in any subsidy scenario we considered. A break-even price for electricity purchased from the utility of 8 ¢ / kWh or higher may be required. Modest energy costs are generally advantageous to businesses in the state, but low electricity prices make energy-related investments less attractive to Nebraska producers than to producers in other regions.

As the size of a livestock operation increases, the fixed capital costs of a digester system can be spread over more animal production units, making both generation of electricity and use of a digester solely for odor control more advantageous. It seems that large dairies in Nebraska and elsewhere could benefit from three types of programs:

1. Tax credits (on the order of \$0.01/kWh)
2. Competitive payments for sale of excess electricity (\$0.04/kWh or more)
3. No-interest loans

In our analysis, these incentives appeared to make investment in methane digestion and cogeneration of electricity most feasible (i.e. had an IRR ≈10%) for larger dairy operations. Synergism between the different policy programs was not considered. Perhaps two or more programs, such as a tax credit and a cost share program would be a more feasible scenario.

It was clear to us that some sort of public policy change or incentive program is needed to allow this technology to penetrate the marketplace. Low retail energy prices relative to other states and a lack of consumer understanding are two major barriers, and it is evident that this technology will not develop in Nebraska without intervention until retail energy costs reach break-even prices or regional restrictions on odor force the implementation of control practices.

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