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The Economic Potential of Methane Recovery for Swine Operations: Projected Impacts of Various Public-Policy Scenarios

Richard Stowell and Christopher Henry[1]

Summary and Implications

Economic analyses were performed on anaerobic digestion of manure from finishing operations. The main factors considered were herd size (1,000 head; 3,500 head; and 10,000 head) and method of financial support provided (cost-share program, no-interest loans, tax subsidies, and subsidized electrical sales).

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. Swine finishing operations looking to invest in this technology would benefit most from a no-interest loan or 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.

Analysis of Anaerobic Digesters in Nebraska

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, the authors evaluated the following direct and indirect support mechanisms: grants (cost-share program), no-interest loans, tax subsidies, and subsidized electrical sales.

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

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represent Nebraska conditions. Three possible 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 looked at livestock farms that would be the most likely to utilize this technology. For swine, the most likely situation would be that of finishing facilities with under-floor pits or pull-plug systems. These facilities could utilize a complete-mix digester and were evaluated on that basis. Systems having very diluted manure (flushing, treatment lagoons, runoff collection ponds, etc.) or solid manure (bedded pack, separated solids, etc.) 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, 1,000-head; 3,500-head; and 10,000-head finishing 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.

Results

The model outputs are presented in three tables. Table 1 addresses the base cost of power generation on a farm. Capital costs include: digester construction, engineering costs, engine generator, solids separator and mix tank. Excess electricity refers to electricity that would not be used for normal operations. The break-even electric price represents the price charged by the utility at which the technology may be feasible without any policy changes.

The modeled capital cost of a digester and a system for electricity generation ranged from roughly $125,000 to $490,000 or from $125 to $50 per head. These costs should be considered

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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 expected capital costs and electric output were projected to increase at fairly similar rates for the complete-mix systems. The bottom line was that the break-even electric price at the largest herd size (8.5 ¢ / kWh) exceeds what most producers are paying in Nebraska (closer to 6-7 ¢ / kWh).

Some operations on livestock farms are fixed consumers of electricity. As a result, smaller farms consume proportionately more energy per head, and little if any excess (saleable) electricity generation should be expected. Note also that the software we used models swine finishing operations as having mechanically ventilated facilities. This makes power generation more attractive than with naturally ventilated facilities since the full electric cost of operating the fans is recouped (at 6 ¢ / kWh) compared to giving away excess electricity or selling it at less than the retail purchase price. Many Nebraska producers choose to naturally ventilate their facilities, so these producers should understand that investments in electricity generation would have higher break-even electric prices and lower rates of return on their operations than indicated here.

Table 2 shows the net present value, simple payback period and internal rate of return for each of the scenarios. Net present value (NPV) is the current value of all cash inflows and outflows of a project at the given discount rate over the life of the project. Simple payback period is the number of years it takes to pay back the capital cost of a project without discounting future revenues or costs. Internal rate of return is the discount rate that makes the NPV of an investment 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 a change in public policy, a positive net present value or rate of return was not obtained for any of the farm sizes. This indicates that methane-fueled electricity generation is not projected to be a profit center on Nebraska finishing operations and confirms the previous findings that the break-even electric price is greater than that currently charged. For the 10,000-head operation, the payback period was less than 10 years, which might be viewed as acceptable by some for long-term investments.

For the finishing operation sizes considered, no policy/price scenarios were projected to make digestion of manure for electricity generation profitable. The no-interest loan and 20% cost-share scenarios were the most advantageous scenarios for finishing operations for each finishing capacity considered.

Table 3 shows the modeled effective cost of recovering methane with a digester for the sole purpose of controlling odor. In this scenario, no electricity was generated and the cost of electric generators was excluded. The effective cost is simply the net present value of the investment (which would be negative) made into a positive number, and equals the capital cost plus the current discounted value of

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expected future operating costs and tax implications. The benefits of a no-interest loan and a cost-share program are shown (in terms of their reduced effective cost) compared to the current situation where no subsidization is available. For finishing operations, the model projected a unitized effective cost ranging from $13 per pig space for a 10,000-head operation taking advantage of a no-interest loan to $57 per pig space for the 1,000-head finisher under current policies.

Conclusions and Implications

Clearly, installation of a digester system is not an insignificant investment. It is also an investment that is currently very difficult to justify economically to Nebraska livestock producers based upon consideration of readily quantifiable income and expenses, regardless of farm size. Modest energy costs are generally advantageous, but they 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.

Swine finishing installations likely would benefit most from a no-interest loan or cost-share program – policies that relate directly to the capital cost incurred.

To compare the effect of the same policy change between species, 1,000 milking cows are nearly equivalent to 3,500 finishing hogs, on an animal-unit basis. Strategies that may work for dairy operations are not feasible for the same ‘size’ of swine operation, however. This can be traced back to the fact that the same “size” dairy generates about 3 times the electricity for 20% higher capital costs (data for dairies not shown).

Installing a digester solely to capture methane and reduce odor emissions involves an expense that producers need to be able to justify. Small producers will likely find the costs prohibitive for obtaining odor control. Larger operations are more likely to place a value on odor control and would experience a lower unitized effective cost than smaller operations. The cost may still be considered unwieldy in an industry with tight profit margins, however.

As more information becomes available about the cost of odor-control strategies, it will be interesting to see how anaerobic digestion compares with other odor-control methods. For illustration, a more rudimentary approach to odor control is to cover a treatment lagoon or manure storage, usually with a floating geotextile fabric. The projected capital cost of covering a manure storage – where more intense odor will be generated than for a treatment lagoon and the area to be covered is less – is a little over $5/pig space for finishing pigs for a 3,500- to 4,000-head operation. An additional likely advantage to using a complete-mix digester is that since the manure is treated, there would be fewer odors generated during application of the manure. Since this is a relatively infrequent activity, one must weigh this benefit with the additional costs incurred with a complete-mix digester.

Low retail energy prices relative to other regions and a lack of consumer understanding of the value derived are major barriers to adoption of anaerobic digestion in Nebraska. Therefore, it seems clear that, unless industry-wide changes in operating practice occur, some sort of public policy incentive will be necessary to allow this technology to penetrate the farm sector. Financial credit is not provided for the environmental and social (odor-control) benefits of this technology so, under current economic conditions, the technology is not economically appealing for individual producers. While not studied in this analysis, it may require a combination of direct and indirect support mechanisms (such as a cost share program and a tax credit) to allow this technology to become economically feasible to swine producers in Nebraska.

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Table 1. Modeled electricity production and base cost of power generation for swine finishing operations.

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	Finishing capacity		
	1,000 head	3,500 head	10,000 head
Capital cost	$125,000	$234,000	$491,000
Max. annual electric output	82,000 kWh	287,000 kWh	820,000 kWh
Excess electricity	0 kWh	7,000 kWh	38,000 kWh
Break-even electric price	23 ¢ / kWh	12 ¢ / kWh	8.5 ¢ / kWh

Table 2. Modeled return on investment from electric power generation for several policy/price scenarios on swine finishers (as a function of finishing capacity).

	Net present value (x $1,000)			Simple payback (years)			Internal rate of return (%)		
Scenario	1,000	3,500	10,000	1,000	3,500	10,000	1,000	3,500	10,000
No Policy (control)	-54	-64	-78	20	11	8.2	< 0	< 0	< 0
No-interest loan	-36	-30	-6	20	11	8.2	< 0	< 0	9
Cost-share = 20%	-39	-35	-16	16	8.8	6.6	< 0	< 0	4
Tax credit									
0.1 ¢ / kWh	-54	-63	-72	20	11	8.2	< 0	< 0	< 0
1.0 ¢ / kWh	-49	-47	-27	20	11	8.2	< 0	< 0	1
Sell electricity									
2 ¢ / kWh	-54*	-64	-73	20*	11	8.2	<0	< 0	< 0
4 ¢ / kWh	-54	-63	-68	20	11	8.2	<0	< 0	< 0

*There is no excess electricity for this size operation.

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

	Finishing capacity					
Scenario	1,000 head		3,500 head		10,000 head	
No policy (control)	$57,000	$57/hd	$98,000	$28/hd	$188,000	$19/hd
No-interest loan	$43,000	$43/hd	$72,000	$20/hd	$134,000	$13/hd
Cost-share = 20%	$45,000	$45/hd	$76,000	$22/hd	$142,000	$14/hd

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