Table 3. **Impact of Electricity Value and Investment on Net Return/Year with and without Grant Funding**

		If grants cover 72% of investment: *Electricity value, $/kwh*		
Investment	$0.060	**$0.085**	$0.150	$0.200
$460,000	**-$1,471**	**$1,586**	$9,534	$15,647
$400,000	$1,112	$4,169	$12,117	$18,230
$350,000	$3,264	$6,321	$14,269	$20,383
$300,000	$5,417	$8,474	$16,422	$22,535

		If grants cover 50% of investment: *Electricity value, $/kwh*		
Investment	$0.060	**$0.085**	$0.150	$0.200
$460,000	**-$9,613**	**-$6,556**	$1,392	$7,505
$400,000	-$5,968	-$2,911	$5,037	$11,150
$350,000	-$2,931	$126	$8,074	$14,188
$300,000	$107	$3,164	$11,112	$17,225

		If grants cover 25% of investment: *Electricity value, $/kwh*		
Investment	$0.060	**$0.085**	$0.150	$0.200
$460,000	**-$18,986**	**-$15,929**	-$7,981	-$1,867
$400,000	-$14,118	-$11,061	-$3,113	$3,000
$350,000	-$10,062	-$7,005	$943	$7,057
$300,000	-$6,006	-$2,949	$4,999	$11,113

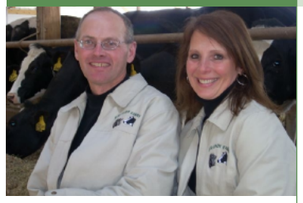
		With no grants: *Electricity value, $/kwh*		
Investment	$0.060	**$0.085**	$0.150	$0.200
$460,000	**-$28,358**	**-$25,301**	-$17,353	-$11,240
$400,000	-$22,268	-$19,211	-$11,263	-$5,150
$350,000	-$17,193	-$14,136	-$6,188	-$75
$300,000	-$12,118	-$9,061	-$1,113	$5,000

improve profitability dramatically. Minnesota's Next Generation Energy Initiative calls for obtaining a quarter of the state's electricity from renewable sources by 2025, up from the current voluntary objective of 10 percent by 2015.

It is not clear how much electricity rates may rise over the next few years due to fossil fuel price increases and policies such as the state energy initiative. Table 3 shows net returns for a digester system over a range of possible electricity rates with the investment level and grant funding that has gone into the Jer-Lindy system. The table also shows how profitability would improve if a way can be found to build the digester more cheaply. Profitability would be worse if less or no grant funding were to be available.

Higher biogas and electricity output would also improve profitability. It is unknown how much output will increase as the herd size reaches the 160-cow capacity. An increase in net output proportional to the cow number increase would be 365 kwh per day rather than the 335 kwh shown in Table 1. The higher manure volume would also reduce residence time in the digester, however, so the biogas output might be less than the increase in cows.

A significantly higher carbon credit price would also improve profitability. Congress recently voted down S. 2191, the Lieberman-Warner Climate Security Act of 2007, which would have instituted a greenhouse gas cap-and-trade program, among other things. According to an analysis by the U.S. Energy Information Administration, the program would have taken effect in 2012 and would have raised the carbon credit price to around $33 per metric ton of CO_2 by 2018, ten years from now. That would be around six times the current price.



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IN PARTNERSHIP WITH

Minnesota Milk Producers Association

Stearns County Natural Resources Conservation Service

Stearns County Soil and Water Conservation District

University of Minnesota Department of Bioproducts and Biosystems Engineering

University of Minnesota Department of Applied Economics

Economic Analysis of the Jer-Lindy Farms Anaerobic Digester

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The economic analysis looks at the projected sources of value generated by the generator and the projected costs of owning and operating it, compared to how the farm might operate in the future without the digester. This "with and without" analysis is slightly different from a "before and after" analysis, because a manure storage pit was also added and 25 stalls were added to the free-stall barn when the digester was installed. The analysis assumes that the extra stalls are filled bringing the herd size up to 160 cows, and leaves the manure storage pit out of the analysis under the assumption that constructing it was a separate decision.

Sources of Value the Digester System is Expected to Generate

The digester is generating electricity, but that is not the only source of value and would not alone be enough to justify the investment. The system is still being optimized and the barn is not yet up to the planned 160-cow capacity, so the value sources discussed here are projections based on expected output for an optimized system with the barn at capacity. With the additional cows and the adjustments that are planned, the economic analysis assumes that the system will produce 430 kwh of electricity per day of which 95 kwh is used per day to operate the pumps, digester and separation equipment. That would leave 335 kwh per day to replace electricity purchases or to sell back to the grid. Jer-Lindy Farms has been paying around 8.5 cents/kwh for electricity. Under Minnesota's net metering law, since the generator is under 40 kw they will be eligible to receive the retail rate for the electricity generated, so it is valued at that 8.5-cent rate in the analysis.

The digester system includes a fan separator. Manure solids from the separator are replacing sand bedding that would cost an estimated $1,000 per month at current prices.

Another possible source of value from the digester system is reduced manure hauling and agitation costs because of solids breakdown in the digester. Some other producers with digesters have reported that there is less crusting in the manure storage pit because of the solids breakdown, so that agitation before pumping is less necessary. The Jer-Lindy pit has not yet been pumped, so it is too early to determine for sure how much agitation will be needed. As rough estimate, if agitation is reduced by 24 hours with two tractors or 48 hours with one tractor and if the tractors cost $50/hour to operate, the savings could be in the neighborhood of $2,400 per year.

Another consideration that is not yet in the analysis is whether separating out the solids will allow the more dilute liquid to be applied at a higher rate on fewer acres, possibly reducing the pumping cost. The

Table 1. Economic Analysis of the Digester

Sources of Value			
Electricity generated		*$/year*	*$/cow*
335 kwh/day x 365 x $0.085/kwh		$10,393	
Bedding @ $75/cow		$12,000	
Reduced manure agitation and hauling		$2,400	
MN Renewable Energy Production Incentive		$1,834	
Carbon credits		$556	
Total Annual Benefits		**$27,184**	
Project Investment	**$ 460,000**		**$2,875**
		$/year	
Engine overhauls — every 3–5 years?		$1,250	
Other O&M (2% of investment?) and labor (0.3 hrs/day?)		$11,390	
Depreciation & interest on digester and mechanicals, 20 year life, 6%		$29,453	
Total Annual Costs		**$42,093**	
Grant funds — covered 72% of the project	$ 329,900		$2,062
Project investment net of grants	$ 130,100		$813
Annualized value of grants amortized over 20 year life		$16,495	
Total Annual Costs Net of Grants		**$25,598**	
Net return/year over operating and ownership costs		**$1,586**	
Years to payback		**11**	

savings will be offset somewhat by the cost of the separate solids spreading operation. Currently three loads of solids are hauled every other week.

The final source of value that considered in the economic analysis is the sale of carbon credits based on the methane destroyed in the digester engine. At the current carbon credit price (around $5.75 per metric ton of CO_2 on the Chicago Climate Exchange on 6/12/08), the value of carbon credits from an operation of this size is likely to be small. Carbon credit values may increase if the U.S. adopts a cap-and-trade or other policy.

Investment Required and Financing

The extra investment required for the digester system included the following items that would likely be fairly similar for any dairy operation of this size (160 cows):

Digester tank, gen-set and set up:	$267,000
Fan Separator:	$36,000
Building costs and concrete:	$33,000
Utility hook up:	$12,000
Flare and boiler:	$13,000
Total for above items:	**$361,000**

plus the following site-specific items that will vary to a greater extent from operation to operation:

Tank insulation:	$32,000
Labor:	$15,000
Additional plumbing and electrical work:	$20,000
Pump and agitator:	$22,000
Excavation:	$10,000
Total for above site-specific items:	**$99,000**
Total Digester Investment:	**$460,000**

Table 2. Economic Possible Future Scenario if a Policy Change Raises the CO2 Price from Current $6/ton to $33/ton, and Electricity and O&M Costs Rise by 20%

Sources of Value			
Electricity generated		*$/year*	*$/cow*
335 kwh/day x 365 x $0.108/kwh		$13,145	
Bedding @ $90/cow		$14,400	
Reduced manure agitation and hauling		$2,880	
MN Renewable Energy Production Incentive			
Carbon credits		$7,703	
Total Annual Benefits		**$38,128**	
Project Investment	**$ 460,000**		**$2,875**
		$/year	
Engine overhauls — every 3–5 years?		$1,500	
Other O&M (2.4% of investment?) and labor (0.3 hrs/day?)		$13,668	
Depreciation & interest on digester and mechanicals, 20 year life, 6%		$29,409	
Total Annual Costs		**$44,577**	
Grant funds — covered 72% of the project	$ 329,900		$2,062
Project investment net of grants	$ 130,100		$813
Annualized value of grants amortized over 20 year life		$16,495	
Total Annual Costs Net of Grants		**$28,082**	
Net return/year over operating and ownership costs		**$10,046**	
Years to payback		**6**	

The pilot project grant funds covered $329,900 of this amount, leaving $130,100 to be covered by the farm operation.

Annual Operating and Ownership Costs

Since digester gen-set engines run 24 hours/day, they typically require overhauls on a fairly frequent basis as well as frequent oil changes and minor maintenance. Every 3 to 5 years is typical for overhauls. The equipment vendor has estimated that the Jer-Lindy engine may cost around $5,000 to overhaul, so if done every 4 years this would amount to $1,250/year. Labor to operate the digester is estimated at 20 minutes/day and valued at $20/hour. Other operation and maintenance (O&M) expenses for items like oil changes are difficult to estimate at this point. Two percent of the digester investment is assumed in the analysis for O&M other than engine overhauls and labor.

Depreciation and interest, or capital service cost, is the largest cost projected for the digester, at $29,453 total or $12,958 net of the grant funding. This cost is estimated based on a 20-year operating life for the digester, straight-line depreciation with no salvage value, and a six percent interest rate on the average investment over that life.

Projected Profitability

Tables 1 and 2 show the economic analysis details. The electricity, bedding value, reduced manure agitation, state renewable energy production incentive, and carbon credits are projected at $27,184/year. This provides a net return of $1,586 over the projected total cost of $25,598. If prices and costs remain at these levels over the 20-year projected life, the investment will be paid back in 11 years.

There is reason to believe that digester profitability may improve over time, however. Higher electricity prices would