Farm Energy IQ

Case Study - Lighting Alternatives for Dairy Barns

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BACKGROUND

A dairy farmer recently had to replace a barn after it collapsed under high snow loads. Rebuilding the barn provided an opportunity to evaluate different lighting options to determine which would be most cost effective. The farmer considered LED lights and more conventional metal halide high intensity discharge (HID) fixtures. The lights operate for an average of 12 hours per day, year round. Electrical costs currently average $0.16 per kilowatt-hour (kWh). For purposes of this exercise, electric rates were assumed to increase 4% each year.

Table 1 lists cost and performance information for the two different fixtures in this study.

Fixture Type:	HID	LED
Material Cost:	$ 160	$ 500
Installation Cost:	$ 100	$ 100
Bulb Watts:	250	203
Total System Watts:	295	203
Average Lumens:	16,000	15,300
Bulb Life (hr):	20,000	160,000
Replacement Cost:	$ 70	$ 200
Years to Replace:	4.6	36.5
Lumens/Watt:	54.2	75.4

Table 1 - Fixture Characteristics

Replacement costs are estimates which assume that the costs of LED lamps will decrease significantly before the lights have to be replaced. The number of years between bulb replacement is calculated by dividing bulb life by bulb operational time (12 hours per day).

Seventeen fixtures are needed, based on the size of the barn and the desired light levels. Although the LED lamps produce about 5% less light than the HID lights, 17 fixtures were sufficient to achieve the desired luminance. Table 2 presents a simplified analysis of the costs of installing and operating each type of light. The costs in Year 1 include installation cost and the cost of operating the 17 fixtures. The annual cost in each subsequent year represents only the cost of electricity. The HID lights need to be replaced more frequently, so there are periodic costs associated with replacing bulbs. The net cost is the initial cost plus periodic maintenance costs less the

savings from using the more efficient LED lights. The cumulative cost is the initial cost plus the cumulative cost of electricity, plus the cost of replacing bulbs during the years when that occurs.

The annual cost of electricity is N x W x H x C ÷ 1000, where

1000 – Factor to convert W to kW

N – number of fixtures (17)

W – watts per fixture (295 for HID, 203 for LED)

H – Hours per year that lights are on (4,383 at 12 hr per day)

C – Cost per kWh ($0.16)

Year	Annual Cost ($)		Relamping Cost ($)		LED Cost Savings ($)	Cumulative Cost ($)	
	HID	LED	HID	LED		HID	LED
1	7,937	17,720			9,783	7,937	17,720
2	3,658	2,517	-	-	8,643	11,595	20,237
3	3,804	2,618	-	-	7,456	15,398	22,855
4	3,956	2,722	-	-	6,222	19,354	25,577
5	4,114	2,831	1,190	-	3,749	24,659	28,408
6	4,279	2,944	-	-	2,415	28,938	31,353
7	4,450	3,062	-	-	1,027	33,388	34,415
8	4,628	3,185	-	-	(416)	38,016	37,600
9	4,813	3,312	-	-	(1,917)	42,829	40,912
10	5,006	3,445	1,190	-	(4,668)	49,025	44,356
11	5,206	3,582	-	-	(6,292)	54,230	47,939
12	5,414	3,726	-	-	(7,980)	59,645	51,664
13	5,631	3,875	-	-	(9,736)	65,275	55,539
14	5,856	4,030	1,190	-	(12,753)	72,321	59,569
15	6,090	4,191	-	-	(14,652)	78,411	63,759
16	6,334	4,358	-	-	(16,627)	84,745	68,118
17	6,587	4,533	-	-	(18,681)	91,332	72,651
18	6,851	4,714	-	-	(20,818)	98,183	77,365
19	7,125	4,903	1,190	-	(24,230)	106,497	82,268
20	7,410	5,099	-	-	(26,541)	113,907	87,366
21	7,706	5,303	-	-	(28,944)	121,613	92,669
22	8,014	5,515	-	-	(31,443)	129,627	98,184
23	8,335	5,735	1,190	-	(35,233)	139,152	103,920
24	8,668	5,965	-	-	(37,936)	147,820	109,884
25	9,015	6,203	-	-	(40,747)	156,835	116,088

Table 2 - Payback Analysis

DISCUSSION AND CONCLUSIONS:

Table 2 shows a simple payback of about eight years. Adding one additional LED fixture to provide the same level of illumination as the HID lights has a payback of less than 10 years. Assuming that the building will last for at least eight years, LED lights can be a reasonable investment for a farmer who has a long term outlook. If electric rates increase by more than 4% a year, then the payback period will be shorter. On the other hand, if electric rates increase more slowly, the payback period will be longer. Using the lights for fewer hours will also increase the payback time. Other factors, among them questions about the long term reliability of newer LED technologies, particularly in a dirty outdoor environment, may influence a decision in favor of the HID lights.

This particular farm has solar panels that meet most of the operation's electrical needs. In fact, in some years the solar panels generate more electricity than the farm uses. When that happens, the farm sells electricity to the regional grid at wholesale prices. Currently, the wholesale rate the farmer receives is $0.04 per kWh. As Figure 1 shows, if all the savings from using the more efficient fixtures are priced at wholesale rates, the payback period increases from eight to 17 years. Under the circumstances, the farmer opted to install the metal halide fixtures.

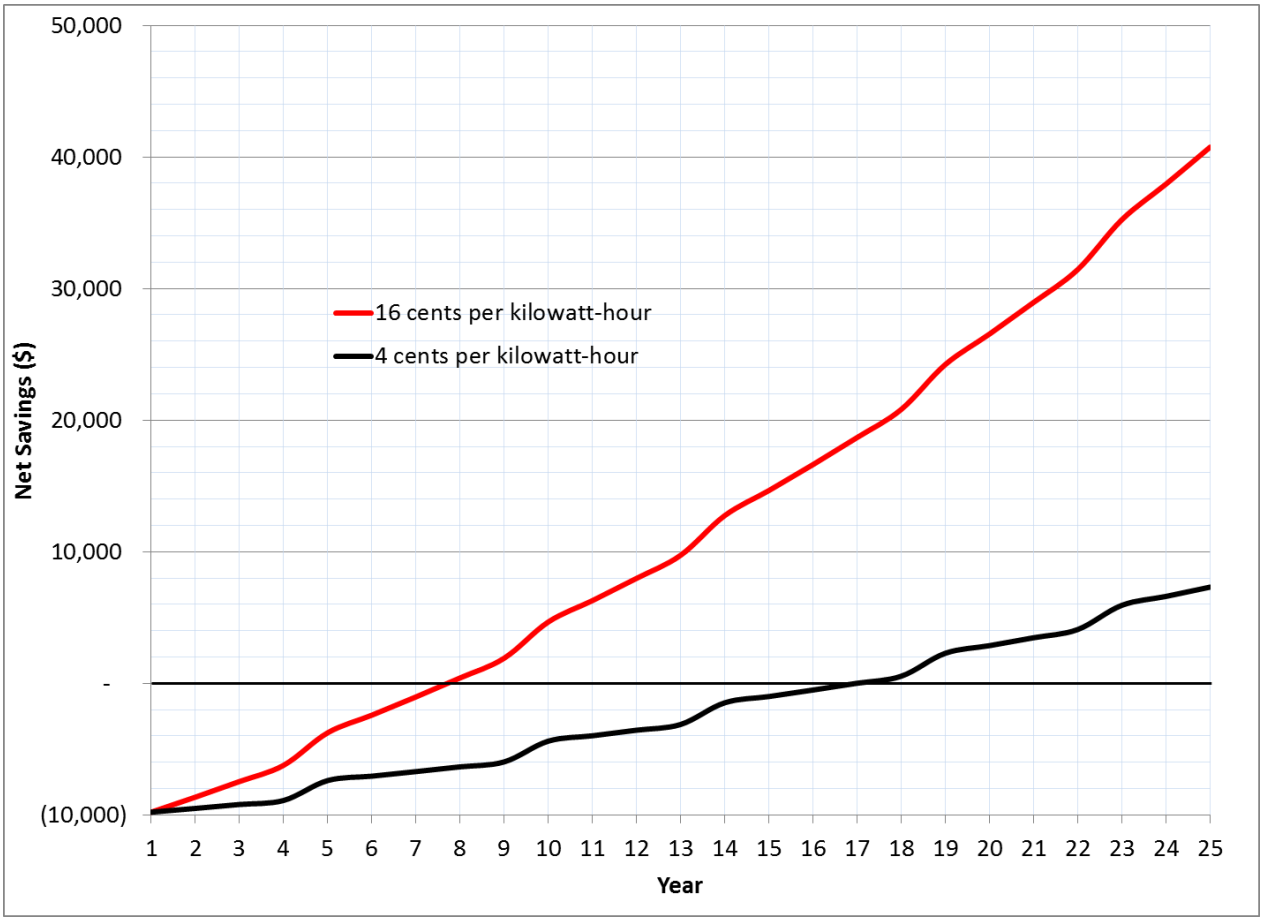

Figure 1- Payback Analysis for Different Electricity Rates

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