FARM ENERGY AUDIT REPORT

for

DAYDREAM FARM
Mr. and Mrs. Dairy Farmer
County Highway
Somewhere, NY
Phone: 000-000-0000

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EXECUTIVE SUMMARY

Daydream Farm is a family dairy located at ----------, Somewhere, NY. The farm is rented and operated by the husband and wife team of Mr. and Mrs. Dairy Farmer.

Mr. and Mrs. Farmer are currently milking 33 cows and have an additional 29 head of young stock including 12 heifers and 15 calves. Projected production is 600,000 pounds of milk shipped annually. Using an around the barn stainless steel pipeline milking system, the herd is milked twice a day. Milk is cooled in a 545 gallon direct expansion Sunset bulk tank.

The milking herd is housed in a tie stall barn. Winter ventilation is accomplished by means of two ½ horsepower fans. Calves are housed in hutches near main barn. Feed storage facilities include ag bags, two grain bins and a hay mow above the main barn. A ration consisting of corn silage, haylage, dry hay and concentrate is fed. Feeding is done primarily with tractors and a gas-powered feeding cart.

Major electrical loads on the farm include 10 kilowatts (kW) of water heating and over 9 horsepower of motors and compressors for milking and milk cooling.

New York State Electric and Gas (NYSEG) supplies and delivers electricity to the farm. The service is billed on the residential day/night rate. The most recent 12 month billing history indicates total electricity consumption for the farm is 42,078 kilowatt-hours (kWh) at a total cost of $5,901.58. Because the first two months of billing reflected less use of electricity in the start up phase of the dairy, annual energy use for audit purposes was estimated at 46,854 kWh and a cost of $6,460.37. Daily electricity expense is $17.75 with an average cost of $0.138 per kWh.

The following table summarizes the electrical energy purchases and related farm data for Daydream Farm – Somewhere, NY.

Table 1. Daydream Farm – Summary of Energy Purchased and Related Farm Data

Summary of Energy Purchased and Related Farm Data - Daydream Farm					
Purchased Annual			**Estimated Annual**		
Electric Energy Use	46,854	kWh	Electric Use	45,426	kWh
Cost per kWh	$0.138				
Annual Cost	$6,460				
Farm Data					
Cows milked		33	Average for year		
Herd Average		18,182	lbs		
Milk shipped, Lbs		Per day	Per year		
		1644	600,000		
Milkings per day		2			
Energy Utilization Index (EUI)				Range	
Farm	1,420	kWh per Cow-yr.		(400-1200)	kWh per Cow-yr.
	$ 195.77	$$ per Cow-yr.			
Vacuum Pump	101	kWh/cow-milking-yr		(25-100)	kWh/cow-milking-yr
	$ 13.91	$$ per Cow-milking-yr.			
Milk Cooling	1.20	kWh/cwt		(0.4 - 1.2)	kWh/cwt
	$ 17.13	$$ per Cow-yr.			
Lighting	300	kWh per Cow-yr.			
	$ 41.39	$$ per Cow-yr.			
Ventilation &	212	kWh per Cow-yr.			
Air Circulation	$ 29.30	$$ per Cow-yr.			

Energy Utilization Indices (EUIs)

The Energy Utilization Indices (EUIs) above are calculated in order to compare the amount of energy used per cow per year at Daydream Farm with the EUIs of other dairy farms. Generally, the Farm EUI for dairy farms will range between 400 and 1200 kWh per cow-year. The Farm EUI of 1,420 kWh per Cow-yr. for Daydream farm is in the upper end of this range indicating the potential for implementing energy conservation measures (ECM) to reduce energy consumption. Annual electric cost per cow is $196.

The vacuum pump EUI of 101 kWh per cow-milking-year is on the upper part of the range expected for dairies with conventional vacuum systems. Dairy farms using variable speed drives to control their vacuum pump can typically reduce this to only 24 – 40 kWh per cow-milking-year. This large difference indicates the potential savings for using VSD technology on Daydream Farm.

The milk cooling EUI of 1.2 kWh used to cool a hundred pounds of milk is typical for a direct expansion cooling system. Regular maintenance to the cooling system, thorough

cleaning of the condenser and an adequate supply of cooling airflow, will go a long way towards ensuring efficient operation of the refrigeration system.

Recommended Energy Conservation Measures (ECMs)

A number of Energy Conservation Measures (ECM) are available to Daydream Farm that would enable them to more efficiently manage their farm electric usage. They include the following;

1. *We recommend installing a **variable speed drive** on the vacuum pump to match vacuum production to actual vacuum use and significantly reduce operating costs...*
    - *The use of a variable speed drive on the vacuum pump maintains desired vacuum level on the milking system and varies the speed of the vacuum pump to produce only as much airflow to meet milking needs*
    - *Variable speed drives can reduce energy use of vacuum suppliers by 40 – 60%. Presently each milking unit uses 1.25 horsepower of vacuum pump capacity. Typically a VSD will reduce this to 0.25 horsepower per unit or just 1.00 Hp of vacuum pump load operating.*
    - *A VSD will reduce vacuum pump operating load by 3.8 kW and save 5,271 kWh over 1,387 hours of annual use. The annual cost savings of $727 can payback the $2,750 investment for a variable speed drive in 3.8 years.*
    - *A VSD will greatly reduces noise generated from the vacuum pump*
    - *A VSD produces very stable vacuum. The VSD responds quickly to changes in airflow keeping vacuum stable. (VSDs react quicker than typical vacuum regulators)*
    - *Reduced operating speed and temperatures can extend vacuum pump operating life.*
    - *May be eligible for an incentive through the NYSERDA Enhanced Commercial Industrial Performance Program (ECIPP) incentive of $100. Go to www.nyserda.org.*

2. *Replacement of existing incandescent light bulbs throughout the tiestall barn with **Compact Fluorescent Lights** (CFL). CFL's offer:*
    - *Greatly increased energy efficiency. A 100 watt incandescent bulb can be replaced with a 24watt CFL, reducing energy use by 75%*
    - *Ease of installation. CFL's can be screwed into existing medium base lamp holders. Use of a protective cover over the CFL is recommended to protect investment in lamp.*
    - *Provide a very quick payback of 0.6 years to recover initial investment (Reduction of 1.45 kW for 1,623 hours use for a savings of 2,350 kWh. The annual cost savings of $324 will pay back the investment of $200 in 0.6 years)*

- *CFL's can last up to 10 times longer than conventional incandescent light bulbs providing efficient lighting with little maintenance labor required.*

3. *Addition of a **refrigeration heat recovery unit** to the bulk tank refrigeration compressor.*
    - *A refrigeration heat recovery unit uses the heat removed from the milk in the bulk tank by the refrigeration compressor to preheat water to 100 to 115 ℉ before entering the water heater.*
    - *This reduces electricity consumption by the electric water heater by 50-60%*
    - *A refrigeration heat recovery unit would pay for itself in 4.8 years. (Savings of 5,460 kWh & $753 calculated in Table 8, page 18 divided by $3,600 implementation cost)*
    - *Additional benefits include increase of refrigeration compressor efficiency during warm summer months.*
    - *Availability of "free" warmed water source directly from the heat recovery unit for calf feeding*

4. *Replace existing open 4 foot, 2 tube, T-12 fluorescent strip fixtures in the tiestall barn with **new enclosed moisture resistant 4 foot, 2 tube, T-8 fluorescent fixtures with high efficiency electronic ballasts.***
    - *The T-8 (1"diameter) lamps in fixtures with high efficiency electronic ballasts will significantly improve the energy efficiency of the lighting system as well as overall lighting performance.*
    - *The new high efficiency fixtures would have a simple payback of 4.5 years with an annual electric energy use reduction of 941 kWh (0.21 kW load reduction x 4,558 operating hours) worth $130 and an estimated implementation cost of $585.*
    - *May also be eligible for an incentive through the NYSERDA Enhanced/Commercial Industrial Performance Program (ECIPP) incentive of $45. Go to www.nyserda.org.*

5. *Replacement of tiestall dairy barn year round exhaust fans with **new high efficiency (≥ 22 cfm/watt) fans**.*
    - *The new high efficiency fans would have a simple payback of 2.8 years with an annual electric energy use reduction of 1,915 kWh (0.262 kW load reduction x 7,314 operating hours) worth $264 to payback the $750 investment in high efficiency fans.*

6. *When the existing reciprocating refrigeration compressor on the bulk tank fails replace with a **new high efficiency SCROLL compressors.***
    - *Reduce refrigeration energy use by 15-20%*
    - *Proven technology, less moving parts, high reliability and low incremental cost ($600)*

- *Can reduce milk cooling energy use by 1,032 kWh (15% reduction of 6,879 kWh milk cooling load) and $142 annually for a simple payback of 4.2 years*

Table 2. Daydream Farms Recommended Energy Conservation Measures

Energy Conservation Measure	Energy Saved kWh	Annual Dollars Saved ($)	Estimated Implementation Costs ($)	Simple Annual Payback Period
1) Install ***variable speed drive*** on vacuum pump motor to match vacuum production to actual vacuum use	5,271	$727	$2,750 $100 NYSERDA Incentive*	3.8
2) Replace incandescent lamps in all barns and milkhouse with ***24 watt screw in Compact Fluorescent Lamps (CFL)***	2,350	$324	$200	0.6
3) Install ***refrigeration heat recovery unit*** to transfer waste heat produced by milk cooling to warm milking equipment wash water	5,460	$753	$3,600	4.8
4) Replacement of nine existing 4 ft, T-12 fluorescent fixtures in the tiestall barn with ***new 4 ft enclosed fixtures with T-8 lamps and high efficiency electronic ballasts***	941	$130	$585 $45 NYSERDA Incentive*	4.5
5) Replacement of tiestall ventilation fans with ***high efficiency (≥ 22 cfm/watt) fans***	1,915	$ 264	$750	2.8
6) Install ***scroll replacement refrigeration compressor*** when current unit fails	1,032	$142	$600 *Incremental Cost*	4.2
TOTAL	**16,968** kWh	**$2,340** Savings	**$8,485** Costs	**3.6** Years

*NYSERDA incentives are available through the Enhanced Commercial/Industrial Performance Program (ECIPP). For more information about NYSERDA incentives, go to www.nyserda.org.

AUDIT REPORT

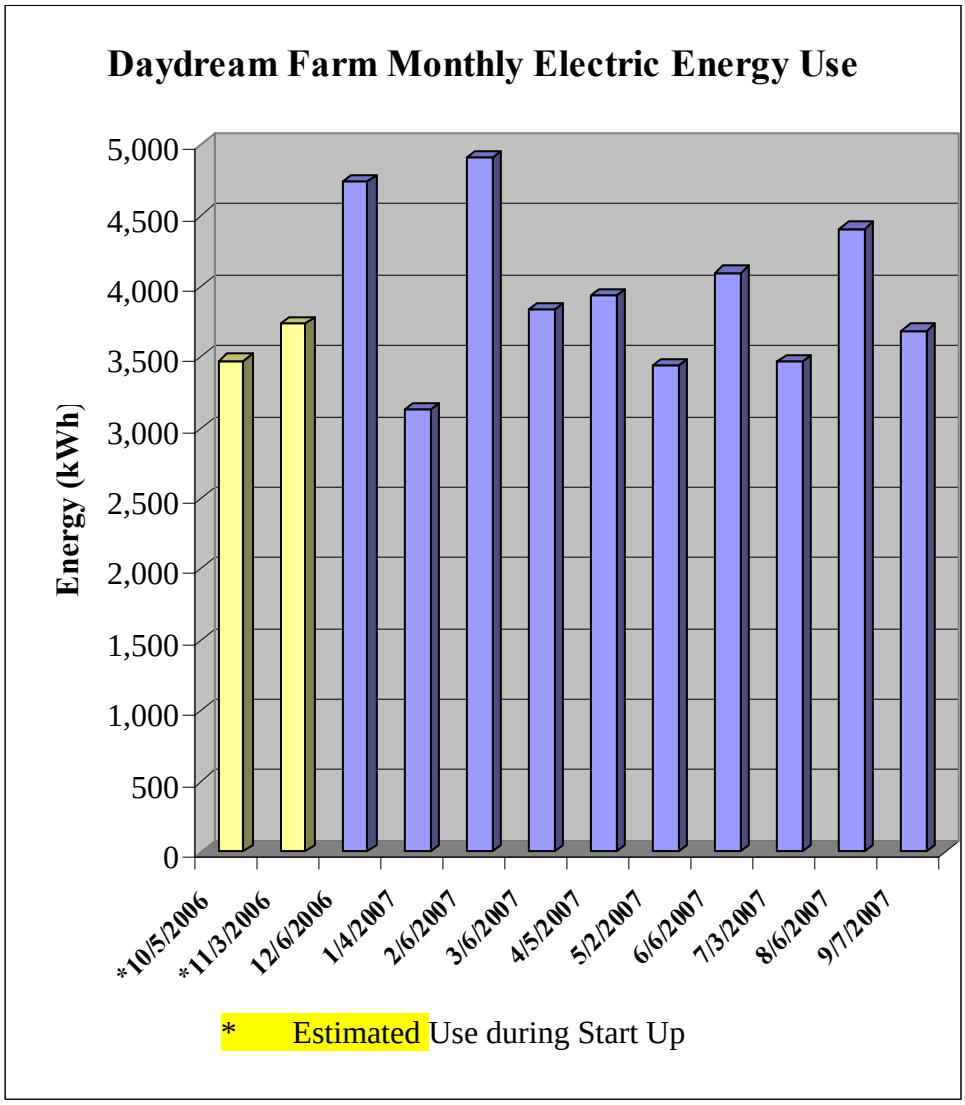
I. Electrical Energy Purchased

One electric meter serves the dairy facility at Daydream Farm. The electrical energy purchased for the farm, was delivered and supplied by New York State Electric and Gas Corp. (NYSEG) under the Non-residential service classification (Rate 12006). In 2006 Daydream Farm used 46,854 kWh of energy at a 13.8 cent per kWh for a total expenditure of $6,460. Electric use for the October and November 2006 billing periods was estimated due to very low consumption during the start up phase for the farm. Electric use for this time period was based on the following ten months of electric use history when full production had been attained.

Table 3 Monthly Electric Use

Non-Residential Monthly Electric Use Summary - Daydream Farms				
	Energy	**Cost**	**kWh**	**$$**
Bill Date	**kWh**	**$$**	**per Day**	**per Day**
***10/5/2006**	***3,475***	***$479.14***	***128.7***	***$17.75***
***11/3/2006**	***3,733***	***$514.72***	***128.7***	***$17.75***
12/6/2006	4,741	$805.79	143.7	$24.42
1/4/2007	3,131	$472.79	108.0	$16.30
2/6/2007	4,910	$580.19	148.8	$17.58
3/6/2007	3,835	$516.28	137.0	$18.44
4/5/2007	3,932	$527.41	131.1	$17.58
5/2/2007	3,442	$439.64	127.5	$16.28
6/6/2007	4,096	$542.44	117.0	$15.50
7/3/2007	3,464	$465.87	128.3	$17.25
8/6/2007	4,407	$607.26	129.6	$17.86
9/7/2007	3,688	$508.84	115.3	$15.90
Totals	**46,854**	**$6,460.37**	**128.7**	**$17.75**
**Estimated Use*		**$0.138**	$/kWh	

Figure 1 Monthly Electric Energy Use



II Electric Energy Use by Equipment Category

The relative amounts of energy used by major equipment categories on the farm were estimated. The chart and table below provides a snapshot of where the majority of electric energy is used at Daydream Farm. The electric water heater is the largest single consumer of energy (24%) on the farm. Ventilation and summer air circulation follows as the next largest user with 21.8%, followed by the milking operation (milk cooling & milking equipment) at 16.6%, then lighting with 15.4% and the vacuum pump at 14.7%. Given that hot water is used for cleaning milking equipment, the milk harvesting process then accounts for over 55% of all the electricity used on Daydream farm.

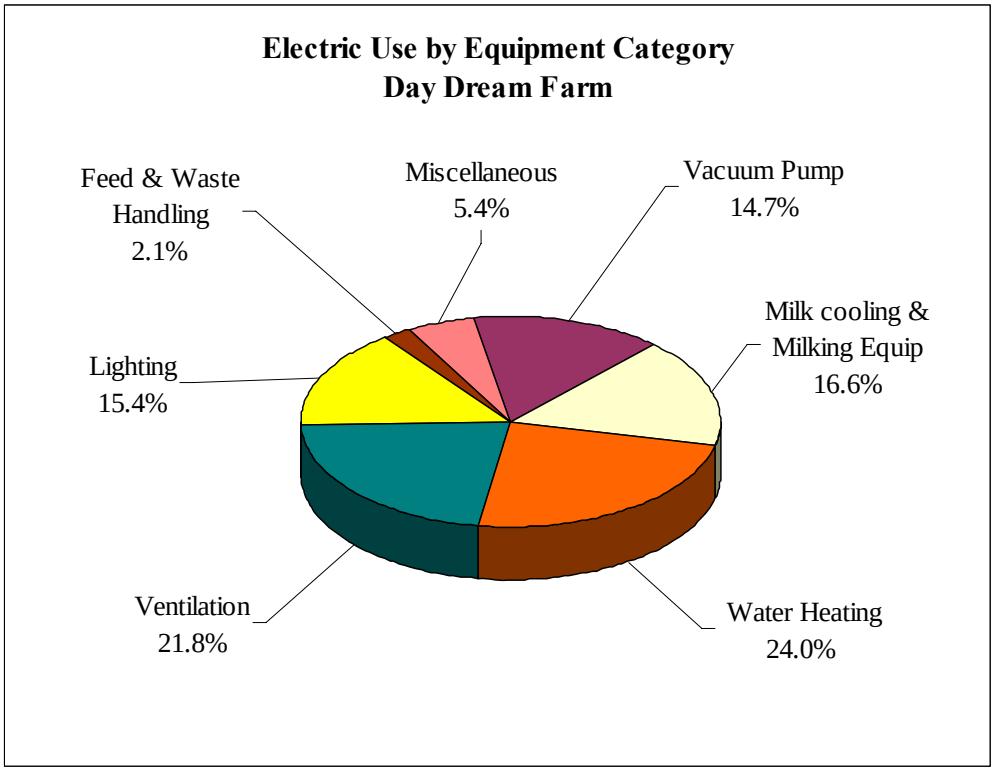


Figure 2 Electric Use by Equipment Category

Equipment Category	kWh	%
Vacuum Pump	6,658	14.7%
Milk cooling & Milking Equip	7,557	16.6%
Water Heating	10,920	24.0%
Ventilation	9,905	21.8%
Lighting	7,011	15.4%
Feed & Waste Handling	943	2.1%
Miscellaneous	2,431	5.4%
Total	**45,426**	

Table 4 Electric Use by Equipment Category

III. Electrical Equipment Inventory

The inventory of farm electrical equipment is given in Table 6 below. Some power requirements for each application were determined using the conversion factors shown at the bottom of the table. The inventory is used to allocate how energy is consumed within individual equipment categories (milk cooling, milking, lighting, ventilation, etc) and identify energy use patterns after leaving the electric meter. The Total Connected Load (TCL) of 34.3 kW on your farm is simply the sum of all the electrical loads in the inventory. The milking operation (vacuum pump, water heater, refrigeration compressor, etc.) comprise 58% of the electric load found on the farm.

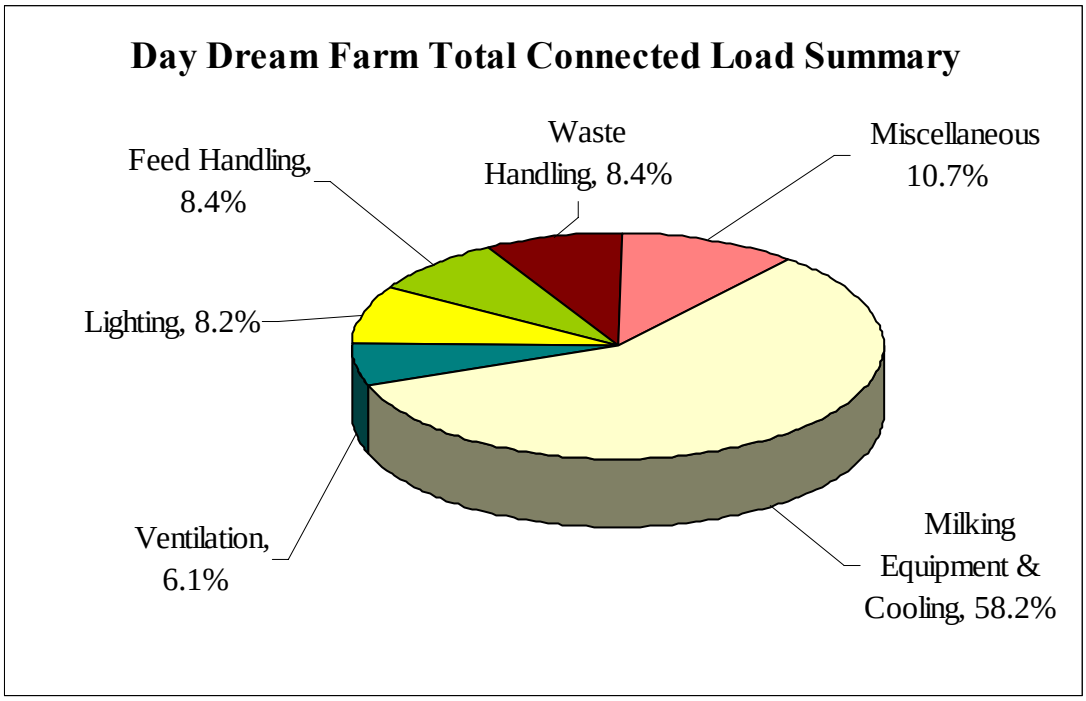


Figure 3 Total Connected Load Summary

Table 5 Daydream Farm Total Connected Load	kW	%
Milking Equipment & Cooling	20.0	58.2%
Ventilation	2.1	6.1%
Lighting	2.8	8.2%
Feed Handling	2.9	8.4%
Waste Handling	2.9	8.4%
Miscellaneous	3.7	10.7%
Total kW Load	**34.3**	

Table 6. Equipment Inventory, Daydream Farm				
Equipment Inventory	**Description**	**Size (Hp)**	**kW**	
Milking Center	***Around the barn stainless steel pipeline***			
Vacuum Pump	Universal centrifugal vane	5.0	4.8	1
Refrigeration Compressor	(1)ICOR International reciprocating type	4.0	3.8	1
Refrigeration Condenser Fans	(2) @ 0.1 hp condenser fans	0.2	0.2	1
Bulk Tank Agitator	545 gal bulk tank w/ 0.17 Hp agitators	0.2	0.2	1
Milk Transfer Pump	1 Hp receiver pump in milk house	1.0	1.0	1
Electric water heater(s)	State 82 gal & AO Smith 50 gal electric		10.0	
Ventilation & air circulation				
Ventilation - Tiestall	(2) @ 0.5 Hp Exhaust fans	1.0	1.0	1
Summer Fans	(3) 1@ 0.5 Hp & 2 @ 0.33 Hp Circulator fans	1.2	1.1	1
Lighting				
Milk house/Utility Room	(3)@ 100 watt Incandescent		0.3	
Tiestall Barn	(7)@ 100 watt Incandescent		0.7	
Tiestall Barn	(9) 4', fluorescent, 2 tube, T-12 fixture		0.8	2
Tiestall Security	(2)@ 100 watt Incandescent		0.2	
Horse Barn	(10)@ 60 watt Incandescent		0.6	
Exterior	(2)@ 100 watt Incandescent		0.2	
Feed Handling	***Feed storage & handling system***			
Feed Bins	Feed load out augers - (2) at 0.75 Hp	1.5	1.4	1
Hay Elevators	(3)Hay Elevators-1.5 HP	1.5	1.4	1
Waste Handling				
Barn Cleaner	New Idea Gutter cleaner	3.0	2.9	1
Miscellaneous				
Engine Block heater	Tractor block heater		1.0	
Water system	Jet Pump	0.5	0.5	1
Miscellaneous	Refrigerator ,power tools, etc.		2.2	
1 - Motors - 0.96 kW per Hp	**Total Connected**	**Load**	**34.3**	
2 - HID and fluorescent lighting	1.15 kW per lamp kW rating			

IV. Estimated Electric Energy Use

The annual electric energy use by each individual piece of electrical equipment on Daydream farm were estimated in Table 7 following. These estimates are based on:

- Information from farm operator
- Typical values on similar farms
- Data logger recording of daily operating hours for the refrigeration compressor, vacuum pump and water heater from similar sized farms.
- Auditors experience from previous analyses.

Daily hours of operation during each month of the year for each piece of equipment are estimated and combined with electric load data from Table 6 to provide a model for energy use on the farm. The annual kWh consumption, hours of use and cost to operate each individual piece of equipment are totaled on the right hand columns of the table for each piece of equipment on the farm. The last two rows in Table 7 compare the estimated modeled monthly kWh with the actual monthly kWh purchases to help verify that accurate estimates are made.

The estimated energy use of 45,426 kWh compared very closely to the actual energy use of 46,854 kWh. The estimated monthly electric consumption is compared with actual monthly billing data on the bottom of the table.

Table 7. Estimated Electrical Equipment Energy Use for Daydream Farms														Total	Hours	Annual
	kW	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**kWh**	**Use**	**Costs**
Milking Equipment		Hrs/day	Hrs/day	Hrs/day	Hrs/day	Hrs/day	Hrs/day	Hrs/day	Hrs/day	Hrs/day	Hrs/day	Hrs/day	Hrs/day			
Vacuum Pump	4.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	6,658	1,387	$918
Refrigeration Compressor	3.8	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	6,552	1,706	$903
Refrig. Condenser Fans	0.2	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	328	1,706	$45
Bulk Tank Agitator	0.2	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	328	1,706	$45
Milk Transfer Pump	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	350	365	$48
Electric water heater	10.0	2.9	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	10,920	1,092	$1,506
Ventilation & circulation																
Ventilation - Tiestall	1.0	12.0	12.0	18.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	18.0	12.0	7,021	7,314	$968
- Summer Fans	1.1	0.0	0.0	0.0	6.0	12.0	12.0	18.0	18.0	12.0	6.0	0.0	0.0	2,884	2,574	$398
Lighting																
Milk house	0.3	4.0	4.0	4.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	4.0	292	972	$40
Tiestall Barn	0.7	6.0	6.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	6.0	6.0	764	1,092	$105
Tiestall Barn	0.8	16.0	16.0	16.0	16.0	6.0	6.0	6.0	6.0	16.0	16.0	16.0	14.0	3,766	4,548	$519
Tiestall Security	0.2	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	1,752	8,760	$242
Horse Barn	0.6	2.0	2.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	292	486	$40
Exterior	0.2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	146	730	$20
Feed Handling																
Feed Bins	1.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	263	183	$36
Hay Elevators	1.4	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	265	184	$37
Waste Handling																
Barn Cleaner	2.9	0.5	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.5	0.5	415	144	$57
Miscellaneous																
Engine Block heater	1.0	4.0	4.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	453	453	$62
Water system	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	44	91	$6
Miscellaneous	2.2	4.0	4.0	4.0	4.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	4.0	1,934	879	$267
														45,426	kWh	**$6,263**
kWh used per day		120	121	125	130	122	123	130	130	128	129	117	119			
Days per Month		31	28	31	30	31	30	31	31	30	31	30	31			
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Total		
Estimated kWh/month		**3,709**	**3,377**	**3,886**	**3,901**	**3,778**	**3,685**	**4,016**	**4,016**	**3,847**	**4,003**	**3,521**	**3,687**	**45,426**	kWh	**$6,263**
Actual kWh per month		**3,131**	**4,910**	**3,835**	**3,932**	**3,442**	**4,096**	**3,464**	**4,407**	**3,688**	**3,475**	**3,733**	**4,741**	**46,854**	kWh	**$6,460**

V. Additional Information about the Vacuum System, Milk Cooling, Ventilation and Water Heating on Daydream Farm.

Vacuum System

Milking vacuum pumps are sized to deliver the required maximum vacuum level to operate the milking and washing systems. Occasionally when a milking unit falls off a cow's udder or when there is a temporary system leak, high levels of vacuum are needed for short intervals. Normal milking operation uses less than half the maximum vacuum pump capacity available. Before variable speed technology was used for vacuum pumps, dairy operators had to run their pumps at a constant high speed to perform adequately during the occasional short intervals of high vacuum need. The VSD determines exactly how much vacuum the system requires by using a sensor located in the balance tank and regulates the speed of the pump accordingly. The result is a pump that runs at a much lower speed most of the time and requires substantially less electricity to do the job.

The relatively high EUI of 101 kWh/cow-milking-year found on Daydream Farm indicates a large potential saving from the installation of a variable speed drive (VSD) on the vacuum pump. Presently the vacuum pump runs continuously at full capacity, and the vacuum controller bleeds off the volume of air not needed for milking.

A VSD, on the other hand, controls the speed of the pump to match pump airflow to milking requirements, while maintaining adequate, stable vacuum to ensure effective milk harvest. A rule of thumb is that every milking unit requires about a quarter horsepower of actual vacuum pump capacity to remove milk from the cow. For an around the barn pipeline with four units operating, this would mean that only 1.00 Hp. of the 5.0 Hp. vacuum pump capacity needs to be operating, saving 4.00 Hp. The remaining four horsepower is available when needed for reserve capacity (i.e. unit fall off, leaks, etc.) and to wash the system. The variable speed drive is able to match vacuum output to actual needs by slowing and increasing motor speed continuously and automatically.

Adding a variable speed drive to your existing vacuum pump motor would be expected to save 5,271 kWh and $727 annually. A 5.0 hp variable speed drive with a projected cost of $2,750 and would have a payback period of 3.8 years

Milk Cooling

Milk precooling was not recommended for Daydream Farm due to payback period of over 7 years. . Although not recommended, precooling could be economical if a used tube or plate cooler could be purchased inexpensively (at a farm auction) reducing implementation costs.

The precooler is mounted in the milk pipeline between the receiver and bulk tank after the milk filter. Water and milk flow through the precooler in opposite directions, to produce the greatest reduction in milk temperatures. As the water and milk pass each

other, the heat from the milk is transferred to the water. The size of the precooler, flow rates of the milk and water through it, and water temperature affect the amount of cooling that can be done before reaching the bulk tank. Typically a precooler can reduce milk temperatures by up to 40ºF (depending on water temperature) and reduce energy used for milk cooling by up to 60%. To maximize amount of precooling, the minimum water-to-milk-flow ratio needs to be at least 1:1 (For each gallon of milk thru the precooler, one gallon of water must flow in the opposite direction.)

Ventilation

Fan Cleaning Procedure

The ventilation fans at Daydream farm were quite dirty. When dirt accumulates on the fan blades and on the basket surrounding the fan, air movement can be decreased by as much as 40%, while energy use can actually increase because of the drag caused by the dirt. A dust build up as little as an eighth of an inch on fan blades can reduce fan performance.

All fans should be cleaned at least 3 – 4 times per year or more often if dirt build-up is noted. When cleaning fans, the power supply should be turned off and the switch locked out so that someone doesn't turn the power back on while the fan is being cleaned. Fans can be cleaned with a blast of high pressure air, but the sticky film that attracts and holds dirt will not be removed by air. Fans can also be cleaned with a vacuum cleaner and stiff-bristled nylon brush to loosen dirt before washing with a sprayer. Care must be taken when using a brush or high pressure washer to avoid damaging the blades. Thus, the best way to clean fans is to wash them with a soapy water solution. After turning the power off, remove the basket from the fan and wash it thoroughly and allow it to dry.

Check the fan blades to see if they are bent or damaged in any way. Replace damaged blades. Then wash down the entire fan and the motor, so that all dirt and oily residue is gone. Dry fan completely, lubricate as recommended, check for proper wiring and reassemble the fan. With proper cleaning and maintenance, a fan will move air at its rated capacity for 5 to 10 years of useful life. Panel fans and box fans should also be thoroughly cleaned and lubricated in the same manner. If the fans are belt driven, check the belt for excessive wear, and replace as needed. Also, check the pulleys for proper alignment and belt tension. Replace any pulleys if the bearings are worn. Be sure to use the same diameter and pitch replacement pulley or fan performance will be jeopardized. Be sure to adjust the belt tension as recommended by the manufacturer. Loose belts can diminish fan performance by 50% or more.

When replacing worn out fans at Daydream farm, consider high efficiency (CFM per watt) fans. While these fans will cost more, they will quickly pay for themselves by reducing energy consumption while boosting ventilation performance. Generally the extra cost of a high efficiency fan will be recovered in 2 – 3 years or less, depending on annual operating hours of the fan.

Water Heating

An 82 and a 50 gallon electric water heater plumbed in series provides hot water on Daydream Farm. The operation of the 82 gallon water heater is controlled with a time clock to limit standby losses between milkings. Hot water is primarily used for daily cleaning of milk harvest and storage equipment and tepid water for feeding calves.

Table 8 provides an estimate of electricity used to heat water and projected savings from heat recovery. The estimated hot water usage of 89 gal/day is based on water heater specs, wash sink dimensions, number of milker units used, and bulk tank size. The ***Projected Annual Electric Use and Cost*** is based on heating 32,655 gallons of water from 50º F to 180º F. The ***Heat Recovery Annual Savings*** is calculated with the same volume of water being preheated by the heat recovery unit from 50 to 115º F by waste heat recovered from the milk cooling by the bulk tank refrigeration compressor. The electric water heaters will then complete water heating to 180º F. Daily hot water use of 2.71 gallons per cow falls on the high end of the expected range of 1 to 2.5 gallons per cow per day for farms of this size. The table on the following page calculates the:

- Amount of hot water heated daily ***(89 gal)*** and annually (***32,655 gal)***.
- Projected cost ***(10,919 kWh, $1,506)*** of heating water with electricity without heat recovery.
- Projected savings ***(5,460 kWh, $753)*** due to refrigeration heat recovery unit.
- Projected savings of tankless propane water heater.

Table 8. Analysis of Electric Water Heating Energy Use at Daydream Farm		
Heating value of Electricity	3.413	kBtu/kWh
Electric cost	$ 0.138	$/kWh
Heating efficiency	95%	
Time period	365	days
Density of water	8.34	lb/gal
Hot water use for washing milking pipeline		
Sink volume	21	gal
Wash water temperature	180	deg. F
Washings per day	2	
Hot water used per washing	41	gal
Daily pipeline wash hot water use	82	gal/day
Hot water use for cleaning bulk tank		
Bulk tank volume	545	gal
Washing per day	0.5	
Hot water used per washing(manual wash)	1	gal/100 tank
Hot water use for tank wash	3	gal/day
Energy used to heat water		
Annual hot water used for washing	31,100	gal/year
Add for incidental use (5%)	1,555	gal/year
Total Annual Hot Water Use	32,655	gal/year
Daily hot water use	89	gal/day
Daily hot water use per cow	2.71	gal/day
Temperature rise	130	deg. F
Total energy required	37,268	kBtu/year
Electricity used per day	30	kWh/day
Projected Annual Electric Use	***10,919***	***kWh/year***
Est. Annual electric cost for water heating	***$1,506***	***$/year***
Estimated Saving with Refrigeration Heat Recovery		
Heat recovery unit capacity	120	gal
Temp. rise from superheat	65	deg. F
Est. Annual Energy Saved	18,634	kBtu/year
Electricity replaced	***5,460***	***kWh/year***
Heat Recovery Annual savings	***$753***	***$/year***
Estimated Cost of Instantaneous Propane water heater		
Heating value of Propane	91.8	kBtu/gal
Cost of Propane	$2.25	$/gal
Burner efficiency	95%	
Projected Annual Propane Use	406	gal/year
Projected Propane Cost	***$913***	***$/year***
Annual Savings	***$592***	***$/year***
Total energy required	37,268	kBtu/year