ENERGY FACTS

FILE 18.85

Cooperative Extension Service
Michigan State University

Extension Bulletin E-1273 February 1979

Energy Management for Dairy Operators[1]

Milk production per cow in the United States requires about 550 kilowatt-hours (kwh) of electricity, about 6 gal of LP gas, and 10 gal of gasoline equivalent annually. In energy cost per cow, this is approximately $35. Through careful management, 10 to 20 percent of the energy used in dairy operations could be saved. For a 50-cow operation, this means a savings of $175 to $350 per year. Figure 1 shows the percentage of energy used by various dairy operations.

Some energy conservation measures require little investment, but others require major changes in management practices and considerable dollars.

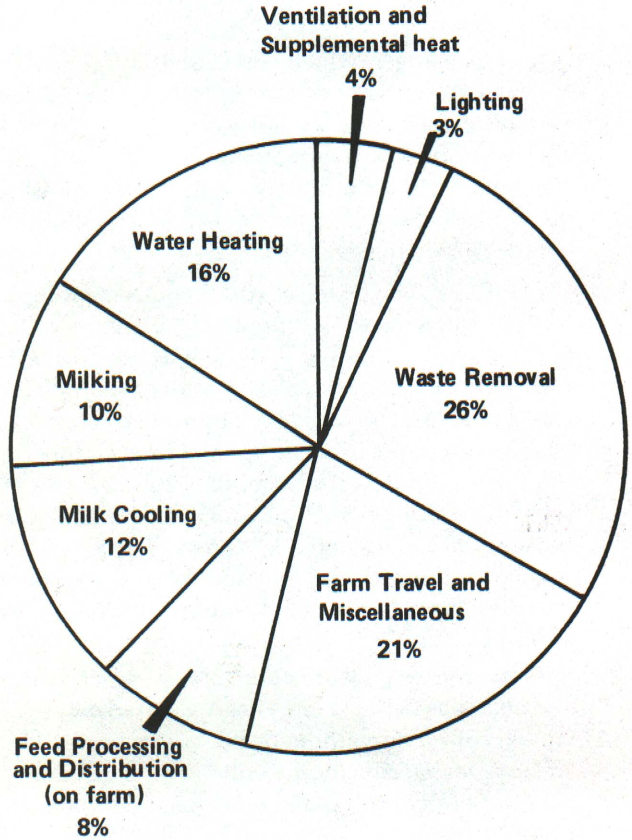

Figure 1. Breakdown of energy use in dairy farming.

Water Heating

Water heating accounts for about 16 percent of the purchased energy on the average dairy farm. With management and planning, from $40 to $200 a year could be saved on an average-sized farm for water heating, without sacrificing high sanitation. Some energy losses are inevitable in the hot water system, but they can be minimized with these routine adjustments:

1. *Fix dripping hot water faucets.* One drip per second wastes 10 or more gal of hot water a day, and costs more than $40 per year.
2. *Minimize hot water use.* Every time water is used there is heat loss in the distribution pipes.
3. *Don't overheat water.* It only accelerates needless heat transfer and loss.

   EXAMPLE: Heating 125 gal of water a day an extra 20°F requires an extra 6.1 kwh of electricity per day (2,230 kwh/yr). At 4 cents/kwh, the extra 20°F costs about $89/yr.
4. *Install spring-operated valves* on heavily used faucets. An Automatic shut-off may prevent daily loss of many gallons of hot water.
5. *Use cold water* when possible for platform and floor cleaning.
6. *Check the float* in the pipeline rinse tank. A maladjustment can waste 5 to 10 gal of hot water each day.
7. *Insulate hot water distribution lines.* Use at least ¾-inch pipe insulation.
8. *Drain and flush* the water heater every six months. With normal use, heaters accumulate solids that prevent efficient heat transfer. Remove these deposits by flushing the sediment out of the heater. Simply open the drain valve and drain 2 to 5 gal of water from the tank, or until the water runs clear. If your water is extremely hard, flush the system monthly.

---

[1]*Adapted from "For the Dairy Farmer: A Guide to Energy Savings" (1977). Federal Energy Administration and USDA, Washington, D.C. By Claudia Myers and Bill Stout, Agricultural Engineering Department, Michigan State University, East Lansing.*

EXAMPLE: A clean system for a 50-cow herd using 125 gal of hot water daily (45,625 gal/yr) and operating near maximum efficiency (3.8 gal/kwh) will require 12,000 kwh/yr to heat the water or $480 at 4 cents/kwh.

In the dirty system, 1 kwh might heat only 3.3 gal of water. Thus, it takes 13,826 kwh/yr to heat 45,625 gal of water. The cost of heating is $553/yr or $73 more than with the clean system.

9. *Use waste heat* from the bulk tank compressor to preheat water. A bulk tank compressor removes heat from the milk in order to cool it. On most dairy farms this heat is lost, and additional energy is purchased to heat water.

   A heat exchanger, which costs about $650 installed, can capture some of this waste heat. A study at Cornell shows a heat exchanger can save 37 to 44 percent of the energy used to heat water.[2] In addition, the exchanger provides better heat transfer out of the refrigerant, saving 5 to 19 percent of the energy needed to cool milk.

   EXAMPLE: The water heating requirement for a 50-cow dairy herd is about 45,625 gal/yr. An average system (3.5 gal/kwh) will use 13,036 kwh/yr to heat the water. At 4 cents/kwh, the cost is $521.44. A 37 percent savings using the heat exchanger amounts to $192.93/yr. The same operation cools 6,000 cwt/hr of milk (120 cwt/cow). It takes 1 kwh/cwt or 6,000 kwh/yr. At 4 cents/kwh, the cost for cooling milk is $240/yr. The 5 percent savings obtained using the heat exchanger amounts to $12/yr. The combined savings is $205/yr.

10. *Before replacing or installing* a water heating system consider: 1) its energy efficiency; 2) temperature and volume of hot water needed for washing or sterilization; and 3) the availability and cost of different fuels. Buy a heater with maximum efficiency.

11. *Install the distribution line* at a lower level than where the hot water leaves the water heater. This will prevent continuous circulation of cooler water out of the distribution pipe and back into the heater. If the distribution line must be hung from the ceiling, use a U-shaped trap to prevent recirculation and reheating.

12. *Use two small heaters* rather than one large heater if economical. Install separate water heaters near the place where the water will be used to reduce energy loss along distribution pipes.

[2] *Turner, C. N. and Richard H. Paft (1959). Bulk milk cooler heats water. Progress report to the New York Farm Electrification Council, Cornell Univ., Ithaca, N.Y.*

Ventilation and Supplemental Heat

1. *Operate fans only when necessary, not continually.*

2. *Operate fan switches manually* in the summer if cows are pastured or fed outside. When cows are outside during the day, the ventilation fans should be turned off. Continuous operation in the summer not only wastes energy but also heats up the barn because warm air from outside is drawn into the barn. However, if young stock or a sick cow is in the barn, perhaps one fan should be kept running.

   EXAMPLES: A 70-cow tie stall operation let the cows outside for about 7 hr/day during the summer. Four fans, each operated by a ¾ hp electric motor, were kept running continuously. At 0.75 kw/hp the 4 motors running for 840 hours consumed 1,890 kwh or $76 during the summer when the cows were outside.

3. *Check and oil* fan motors regularly.

4. *Do not use resistance element multispeed fan motors.* Multispeed fan motors of the resistance element type draw the same amount of current whether operating at low or high speed.

5. *Check and clean* all heating systems.

6. *Turn off the heating system* in the summer, including the pilot light. The whole system can be turned off by shutting off the gas line valve leading to the space heater.

7. *Insulate the milkhouse and parlor.* The amount of insulation needed will depend on the cost of the insulation and fuel costs. It is important that a proper vapor barrier be installed to prevent moisture from penetrating the insulation. Consult your local Cooperative Extension agent for information on the break-even point between insulation and fuel costs.

8. *If ventilation is used in the barn, insulate where possible.* Heat helps remove moisture from the barn. In the winter excessive heat loss through the walls and roof can cause moisture condensation. But, the cost of insulation is substantial. Check with your Extension agent to determine the break-even point between the costs of additional insulation and a lower energy bill.

Milk Cooling

Milk cooling may require 10 to 15 percent of the energy used in typical dairy operations. While this percentage is not a major share, milk cooling deserves close attention because it uses the most expensive energy form—electricity. The cost of electricity averages about 4 cents/kwh. Electricity costs 3 to 4 times as much as the same amount of energy from other fuels, such as LP gas and diesel fuel.

Dairy farmers use ice builders and direct expansion coolers to cool milk. The latter often need a larger compressor than the ice builder, but they use less energy per unit of milk cooled. The ice builder needs more energy because: 1) an electric motor is needed to circulate ice water; 2) the compressor operates intermittently to keep the ice bank built; and 3) when the bulk tank is empty, the sides of the ice bank cooler are kept at the cool shut-off temperature. (The direct expansion cooler is completely shut off, and its sides are allowed to warm to room temperature.) However, the ice builder may be more economical than the direct expansion cooler when operated during "off peak" demand periods, such as early morning and evening.

1. *Check and oil* the electric motor when necessary.
2. *Check the alignment* and tightness of the fan belts.
3. *Keep the fins on the compressor head clean* and free of buildup.
4. *Clean the screen* covering the vent outlet.
5. *Make sure the compressor head* is adequately ventilated. Don't restrict the air flow—the condensing unit should be at least 18 inches from the wall.
6. *Keep condenser coil clean.*
7. *Have the compressor serviced yearly.* This could involve adding freon or another volatile substance, measuring head, back and suction pressures plus head temperature, and the use of equipment not readily available. Poor adjustment of the compressor can increase the energy needed for cooling as much as 25 percent.

   EXAMPLE: An ammonia compressor system containing 3 percent air reduces the efficiency of the system 17 percent. A 50-cow dairy herd with a 12,000 lb herd average requires about 6,000 kwh/yr ($240/yr) of electricity to cool the milk when the compressor is running properly. With a 17 percent reduction in efficiency, an added $40 worth of electricity is required.
8. *If purchasing a milk cooler*, ask about the type of refrigerant. The type affects the amount of back pressure that can be allowed to achieve a desired temperature. The back pressure in turn affects the energy efficiency of the system.
9. *Ventilate the compressor's waste heat* into the parlor if possible during winter. Ventilate it outside during the summer or use it for water preheating.

Vacuum Pumps

Milking requires 10 percent of the energy used on the average dairy farm. Because milking equipment is used every day, even modest economies will produce a savings over the years.

Two vacuum pumps are commonly used: the rotary vane and the centrifugal water displacement pump. The latter, with no metal-to-metal contact, has great durability, but is expensive and not well suited to hard water. The rotary vane pump is used most often.

The number of cubic ft per minute that a vacuum pump will produce depends on the amount of vacuum, the age of the pump and the revolutions per minute at which the pump is run. The pump operates at full capacity whether it is being used at full capacity or not. The excess vacuum generated is handled by "bleeding-in" air through a vacuum controller. A vacuum line needs one controller for each 25 cubic ft per minute produced by the pump.

When purchasing or operating a vacuum pump, keep the following in mind:

1. *Select a vacuum pump* that meets but does not exceed your needs. The motor size of the vacuum pump depends on the pump, the cubic ft per minute required and the dealer. If a 3-hp motor is adequate, using a 5-hp motor is a waste of energy and money.
2. *Clean the screen* around the air inlet on the vacuum controller to prevent clogging.
3. *Keep belts properly tightened and aligned.*
4. *Maintain the proper oil level.* Numbers 3 and 4 alone can increase the efficiency of the vacuum pump by 2 to 5 percent and prolong the life of the pump and motor.

Electric Motors

The purchase price of a motor is only part of its cost. There is the cost of the energy required for daily operation as well. Usually, the most efficient motor will be the cheapest in the long run. The type of electric motor to use depends on the starting torque requirement of the equipment.

Fans have low starting torque; therefore, split phase motors are satisfactory. Capacitor start-induction run motors have a medium starting torque and are excellent for vacuum pumps and conveyors. Barn cleaners and silo unloaders have high starting torque and require start-capacitor run or repulsion-induction motors.

You may want to consider three-phase motors. They cost less, are dependable and normally operate more efficiently than single-phase motors.

The individual dollar savings realized by careful planning, purchase and use of electric motors appreciate over the lifetime of the motors. But as with other equipment you must follow operating recommendations. Benefits accrue when these maintenance practices are followed.

1. *Clean dust and dirt from motor* to ensure proper cooling.
2. *Avoid over-lubricating oil bearings.*
3. *Clean starting switch contacts or brushes.* Use very fine sandpaper, not emery cloth.
4. *Be sure the motor shaft turns freely.* Tight or

misaligned bearings will cause the motor to overheat and waste energy.

5. *Replace worn belts.*
6. *Make sure the motor is secure.* Poor mounting causes excessive bearing wear and loss of electric power.
7. *Maintain proper belt tension.* The belt should be "snug" in the grooves but not "taut." If the belt is too loose, it will slip and cause overheating and excessive belt wear. If it is too tight, it will cause excessive wear of motor bearings.
8. *Check bearings for wear.* Excessive side or end play may waste current.

Lighting

Lighting accounts for 3 to 6 percent of a typical dairy farm's total electric bill. Its use, however, can sometimes be cut in half by turning off unnecessary lights and using the right bulb and clean fixtures. For example, one 110-watt bulb left on overnight (12 hr) consumes 1.3 kwh. This could add $20 a year to the average electric bill. Also, a 16 percent energy savings is possible using a 100-watt incandescent bulb for two 60-watt bulbs.

Sometimes, extended-life lamps are more economical even though the lumen output is 10 to 15 percent less. Before changing lighting, however, walk around facilities, both indoors and outdoors, noting areas which appear over- or underlighted. An individual evaluation of the amount of light needed may be adequate. To be more accurate, use a light meter to match the amount of light provided to tasks performed in a particular area. Hold the light meter 30 inches from the wall and 30 inches from the floor to obtain the correct reading. Light from old bulbs will be weak, giving an inaccurate indication of the light level when new bulbs are installed.

Recommendations for reducing energy consumption for lighting include:

1. *Use fluorescent*, rather than incandescent, bulbs wherever possible indoors. They provide about 4 times as much light per unit of energy as incandescent bulbs.

   EXAMPLE: Six 100-watt incandescent bulbs put out the same light (9,600 lumens) as three 40-watt fluorescent bulbs. The electricity to power the incandescent bulbs for six hours a day would cost about $52/yr, compared with about $13/yr for the fluorescent. In this case changing from incandescent to fluorescent would lead to an electrical savings of $39/yr.
2. *Consider mercury vapor*, metal halide or high pressure sodium lamps for large areas outdoors. A mercury vapor lamp provides more than twice as much light per watt as do standard incandescents; a metal halide lamp provides 4 times as much and a high pressure sodium, 5 times as much (Table 1). The drawback for these lights, however, is that they require 3 to 10 minutes start-up time.
3. *Clean light fixtures.* A clean 25-watt bulb with a clean reflector has the same light intensity as a clean 40-watt bulb with no reflector or a dirty 60-watt bulb with no reflector.
4. *Eliminate unnecessary lights.*
5. *When removing a fluorescent lamp*, disconnect the primary side of the ballast. The ballast draws energy even after the removal of the bulb.
6. *Replace dim or fading fluorescent bulbs.* Their efficiency is decreasing rapidly.

TABLE 1. Lighting Chart

Type of lamp	*Size by watts*	*Average output in lumens*	*Approximate lumens per watt*[1]	*Average hours of life*[2]
Standard incandescent	25	225	9	
	40	480	11	
	60	810	14	750
	100	1,600	16	to
	150	2,500	17	1,000
	200	3,500	18	
	300	5,490	18	
Standard fluorescent	15	660	34	
	20	1,000	40	
	40	3,200	66	18,000
	60	4,080	68	
	75	5,475	78	
Mercury vapor	75	2,800	40	
	100	3,800	40	
	175	7,500	40	24,000
	250	11,600	45	
	400	21,000	50	
	700	39,000	50	
Metal halide	175	12,000	65	
	400	34,000	80	18,000
	1,000	95,000	90	
High pressure sodium	250	25,000	80	
	400	47,000	160	20,000
	1,000	130,000	110	

[1]*Includes the power requirement for the ballast when appropriate.*

[2]*These hours vary, and you should check the specifications on the package. "Long-life" incandescent bulbs are available in the range of 3,500 hours, but they deliver 10-15 percent fewer lumens per watt.*

This information is for educational purposes only. Reference to commercial products or trade names does not imply discrimination or endorsement by the Cooperative Extension Service. Cooperative Extension Service Programs are open to all without regard to race, color, or national origin. Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8, and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Gordon E. Guyer, Director, Cooperative Extension Service, Michigan State University, E. Lansing, MI 48824

0-11222 *1P-10M-1:79-UP, Price 10 cents, Single copy free to Michigan residents.*