Managing Energy Costs in Dairy Farm Facilities

Energy usage on dairy farms has grown over the past 20 years due to increases in farm sizes, use of automated equipment, and around-the-clock operation. Dairy farms in the U.S. typically consume between 800 and 1,200 kilowatt-hours (kWh) per cow annually. Energy-saving measures can cut those numbers significantly, boosting your bottom line and freeing up funds for other uses.

How Dairy Farms Use Energy

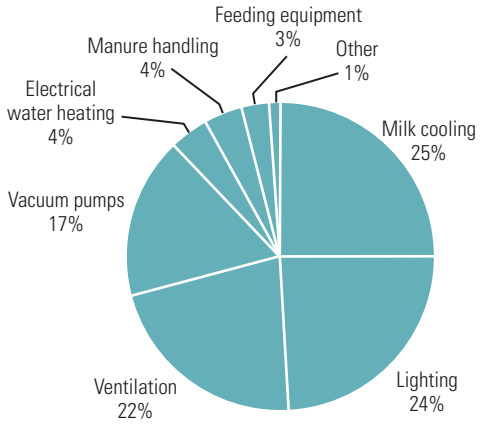
Although the relative energy consumption of different processes varies somewhat depending on the dairy farm, about 50 percent of the total electricity used generally goes toward milk-production equipment, which includes milk cooling, vacuum pumps, and water heating. Lighting and ventilation account for most of the remainder of the electricity consumed (**Figure 1**).

Quick Fixes

Many dairy farms can benefit greatly from low- or no-cost energy expenditure reductions, such as turning things off, turning things down, and keeping up with cleaning and maintenance.

FIGURE 1: Electricity consumption in a dairy farm

Milk cooling, lighting, and ventilation generally represent the largest sources of electricity consumption in dairy farms, making them good targets for efficiency improvements.



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Turning Things Off

It's the simplest of ideas. Remember that every 1,000 kWh you save by turning things off is equivalent to taking $100 off your utility bill (assuming average electricity prices of $0.10/kWh).

Lights. Turn off lights when they're not in use. For ideas on how to do this automatically, see the Lighting section on page 3.

Fans. Proper ventilation is essential for the health of livestock, but there may be times when fans can be turned off. Installing automation controls like thermostats can help save energy while maintaining healthy barn conditions.

Turning Things Down

Some equipment cannot be turned off entirely, but turning it down to minimum levels where possible can save energy.

Take advantage of daylight. In spaces where natural lighting is available, turn off or dim lights when there is sufficient daylight to illuminate an area.

Reduce air-compressor pressure. Drop the pressure on your compressors to a level that meets your needs. Reducing your compressor setpoint by 20 pounds per square inch can reduce compressor energy costs by 10 percent. By reducing system pressures, you will also be reducing system leak rates and increasing the life of your equipment.

Set water temperatures appropriately. Turning water-heater temperatures down by 10° Fahrenheit (F) will decrease water-heating costs by 3 to 5 percent. However, be sure to keep temperatures above process requirements—for example, washing systems may require water temperatures to be at least 160°F.

Cleaning and Maintenance

Regular cleaning and maintenance can help to ensure that equipment operates efficiently and as expected.

Clean heat-exchanger coils. The heat exchangers in milk-cooling systems are designed to be opened and cleaned on a quarterly basis. Cleaning condenser coils alone can reduce milk-cooling costs by 3 to 5 percent.

Clean fans. Failure to clean fans and shutters, which provide ventilation and circulation, can reduce ventilation efficiencies by as much as 40 percent and will increase the risk of fire. Lubricating any motor bearings and shutter pivot points with machine oil at least once a month ensures optimal operation. Also, check fan blades regularly for any damage—replacing fan blades is much more cost-effective than replacing an entire fan.

Keep lights clean. Clean lighting fixtures and bulbs so that they will continue to perform as designed. Maintaining lighting equipment will also help ensure that workers have enough light to perform their tasks.

Check water heaters. Minimizing corrosion can boost water-heater efficiency. If required, anode rods (located inside the water heater) can be replaced to increase the water heater's lifetime. Gas combustion burners should also be inspected annually. An easy way to do this is to open up the combustion chamber hatch—if the combustion chamber is blackened, call a technician to take a look.

Conserve water. Another effective way to reduce water-heating costs is through water conservation. Having your dairy equipment dealer tune up your pipeline washing system can reduce the amount of water required for washing dairy equipment, which in turn reduces your water heating loads.

Check pumps. Pumps should be cleaned and maintained periodically to uphold good operating performance. Motors in pumps that have accumulated dust can overheat, which will decrease the efficiency and lifetime of the pumps and can increase the risk of fire. Also, poor contact on motor power terminals can result in premature motor failure. Check power terminals monthly to make sure that they remain tight.

Replace pump and fan belts. Belts are often used to transfer power from the motor to pumps and fans. Standard V-belt drives, the lowest-cost option, are found in the majority of belt applications. When new, V-belts typically achieve efficiencies in the range of 90 to 95 percent. A worn belt, however, can considerably reduce the efficiency due to slippage caused by slackening and worn grip surfaces. Cogged V-belts are similar to standard V-belts, except that the normally flat underside has longitudinal grooves in it, allowing better grip and less slip than standard V-belts. This results in efficiency improvements of 2 to 5 percent over a standard V-belt.

Longer-Term Solutions

Although the actions covered in this section require more-extensive implementation efforts, they can dramatically increase the efficiency of your dairy farm without compromising speed or reliability. Ask a local utility representative for more information about initiating such projects.

Refrigeration

Milk cooling is an energy hog in dairy facilities, typically representing about 25 percent of the electric bill. However, there are a couple of different technologies that can significantly reduce refrigeration energy consumption.

Scroll compressors. Dairy farms have traditionally used reciprocating compressors for milk-cooling systems, but in the last 10 years they have started to use scroll compressors, which can reduce compressor energy costs by as much as 20 percent when compared to traditional reciprocating compressors. In addition to being more energy efficient, scroll compressors are also quieter and produce less vibration because there are no valves and they have only one moving part.

Water-cooled precoolers. Running well water through heat exchangers to precool milk before it enters the refrigerated milk tank can reduce milk temperatures by as much as 30°F and cut cooling costs by up to 50 percent. If you already have a refrigeration heat-recovery system in place, check that a water-cooled plate cooler will not negate the benefits of the heat-recovery system (plate coolers will reduce the amount of heat generated by refrigerated milk tanks, thereby making less heat available to the recovery system). When weighing the benefits of heat-recovery systems versus water-cooled plate

coolers, it is best to conduct an energy audit to analyze the cost benefits for your particular farm.

Pumping

Pumping systems consume almost a fifth of all of the energy on dairy farms.

Correctly size pumps. When purchasing pumps, be sure to size them correctly—oversized pumps are unnecessarily costly and will result in increased energy consumption because they will cycle on and off more frequently than a standard-sized unit.

Variable-speed drives (VSDs) for pumps. VSDs use integrated controls and sensors to drive pumps at the lowest possible speed to perform the required job. The savings from VSDs can add up quickly because motor speed greatly affects the power drawn; for example, a 50 percent reduction in pump speed can result in an 88 percent decrease in motor power. Purchasing VSDs for vacuum pumps and milking pumps can often prove to be economical, though smaller farms—those with fewer than eight hours of milking per day—may not be able to offset the capital costs of VSDs with energy savings. In most dairy farm applications, replacing constant-speed pumps with VSD pumps can reduce pumping energy consumption by half. An additional benefit of VSDs when applied to milk-transfer pumps is that by slowing the rate of flow, the milk can spend more time in the heat exchanger, allowing it to be cooled by an additional 15 to 20 degrees.

Water Heating

Hot water is generally produced using fuel oil, natural gas, propane, or electricity, and, on some dairy farms, can account for nearly 25 percent of total energy use.

Heat-recovery systems. An efficient way to heat water on dairy farms is to recover heat energy from the refrigeration condenser units used to cool milk. In addition to saving energy by preheating water, heat-recovery systems also increase the refrigerator's heat-exchanger efficiency because heat-transfer rates are higher between refrigerant and water than between refrigerant and air. Up to 50 percent of a farm's water-heating requirements can be met through heat-recovery systems.

High-efficiency water heaters. The thermal efficiency of water heaters varies greatly depending on the water heater type. Though electric water heaters can operate at nearly 100 percent efficiency, gas and oil water heaters will typically have lower operating costs because the cost of gas and oil is generally less than the cost of electricity. When looking to save energy in water heating, consider purchasing a high-efficiency oil or gas condensing water heater, which will recover more of the heat from the combustion gases. Condensing water heaters have thermal efficiencies of more than 95 percent, compared to about 80 percent for conventional units.

Ventilation

Ventilation is essential for creating healthy conditions in dairy farms (for cows and workers alike). The following measures can reduce energy consumption while maintaining or improving the effectiveness of the system.

High-efficiency fans. Ventilation energy costs depend on the efficiency of the fans. When looking for new fans, be sure to pay attention to the air-circulation system design, the blade design, and the level of efficiency. One solution is to use high-volume, low-speed fans, which provide widespread air movement but consume much less energy and produce less noise than high-speed fans.

Controls. For optimal ventilation, fans should be controlled by programmable thermostats set to meet livestock needs. Install the thermostat in a location that will accurately measure air temperature (generally at least 10 feet from a fan and 1 foot below the ceiling), and be sure to clean the thermostat regularly to prevent dust buildup.

Lighting

Energy-efficient lighting is an easy way to reduce energy costs, especially on farms that use the technique of long-day lighting, in which lights are left on for 18 hours a day to increase milk production.

T8 fluorescent lamps. If your dairy farm uses T12 fluorescent lamps, relamping with modern, electronically ballasted T8 lamps can reduce your lighting energy consumption by 35 percent. These lamps should be enclosed in water-resistant

fixtures. Adding specular reflectors, occupancy sensors, or timers can increase savings substantially. Paybacks of one to three years are common.

Use CFLs and CCFLs. If you are still using incandescent lamps, replace them with compact fluorescent lamps (CFLs). CFLs use one-quarter of the energy and last up to 10 times as long. In areas where lamps are dimmed or frequently cycled on and off, consider cold cathode fluorescent lamps (CCFLs), which, though more expensive, last even longer than CFLs and are easier to dim.

Other light sources. If your farm uses old probe-start metal halide fixtures, replacing them with high-performance T8 fluorescent lamps or pulse-start metal halide (PSMH) fixtures that have electronic ballasts can cut energy use by as much as 50 percent. In addition, the lamps will last longer, maintain their light output at higher levels, and start up more quickly. Another option, especially in areas where lights can be hard to replace, is induction lighting, which offers very long life.

Outdoor yard lights. When selecting outdoor lights, consider fluorescent, low-wattage PSMH with electronic ballasts, high-pressure sodium (HPS) fixtures, or LEDs rather than high-wattage quartz or incandescent fixtures. PSMH lamps are less efficient than HPS lamps in conventional terms, but they put out more light in the blue part of the spectrum, which is easier for our eyes to see under low-light conditions. This allows for the use of a lower-wattage PSMH lamp. Fluorescent lamps can be used outdoors as long as their ballasts are rated for cold-weather starting and the fixture is rated for a damp environment. LEDs are still costly but offer long life and high efficiency in outdoor applications.

Lighting controls. Lighting controls can help cut lighting energy use indoors and out. Indoors, photocells can be used to dim lights in response to available daylight—especially useful in barns with translucent sidewalls. Timers can be programmed to turn lights on and off to meet livestock needs, and motion sensors can control lights in hallways and other areas where farm personnel are moving in and out. Outdoors, a photocell control will turn a light on at dusk and off with the daylight. Newer photocells can dim or turn lights off in the middle of the night if they are no longer needed.

Anaerobic Digesters

Anaerobic digestion is a solution to managing agricultural waste from cows that can also reduce energy costs. In addition to providing a treatment route for manure with fertilizer as an end product, running a generator off the produced biogas can bring in revenue for the farm. Estimates show that dairy anaerobic digesters could produce between 4 and 5 kWh per cow, per day. With concentrations of more than 100,000 cows at some operations, the potential energy resource is huge. For more information on anaerobic digestion, refer to the U.S. Environmental Protection Agency's report "Anaerobic Digestion" (**www.epa.gov/agstar/operational.html**) or the fact sheet "Anaerobic Digester—Controlled Temperature," created by the Natural Resources Conservation Service (**ftp://ftp-fc.sc.egov.usda.gov/MI/technical/engineering/MichiganAnaerobicDigesterFactSheet_1-19-06.pdf**).

The Bottom Line

The conservation measures discussed above represent good investments. Not only will they help you to save money on your energy bills, but they will also increase your farm's competitiveness by boosting your bottom line. Also, be sure to check for any federal or local utility incentives that can help you jump-start your energy-efficiency projects.

Resources

National Sustainable Agriculture Information Service, "Dairy Farm Energy Efficiency," **http://attra.ncat.org/attra-pub/dairyenergy.html**. This page provides an overview of different strategies for reducing energy consumption in dairy centers.

Southern California Edison, "Dairy Farm Energy Management Guide," **www.sce.com/b-sb/design-services/dairy-farm-energy-efficiency-guide.htm**. Although focused primarily on dairy farms in California, this guidebook discusses a variety of efficiency measures applicable to any dairy farm.