Energy-saving practices for dairy operations

Note: *Data in this series were obtained through the Missouri Agricultural and Energy Savings Team – A Revolutionary Opportunity (MAESTRO) program. The MAESTRO program was created to strengthen the financial viability of Missouri's livestock producers through energy efficiency. Specifically, participants in the program were livestock producers who were not required to be permitted as confined animal feeding operations (CAFO). MAESTRO was a grant-funded program that provided cost-share assistance to implement energy-efficient practices recommended in energy management plans through low-interest loans and rebates. Although these guides refer to energy savings in Missouri, many of the concepts described may apply to operations throughout the Midwest. Visit* http://extension.missouri.edu/energy *if you are interested in more energy-saving recommendations.*

Photo credit: USDA-NRCS

The dairy industry continues to be an important component of Missouri's economy. According to the University of Missouri's *Dairy Resource Guide* as of December 2012, Missouri had 1,348 permitted dairy operations. Of these operations, 950 were Grade A dairies and the remaining 398 were manufacturing dairies. According to the U.S. Department of Agriculture's *Milk Production Report of 23 Selected States*, Missouri's milk production averaged 109 million pounds in July 2013. Dairy operations use a considerable amount of energy to move and cool milk. However, implementing energy-efficient measures recommended in an energy audit can provide substantial energy and monetary savings. An energy audit is an in-depth examination that determines:

- if and how energy is being lost,
- which systems are operating inefficiently, and
- what type of cost-efficient measures can be implemented to make the farm more energy-efficient.

To explain further, an energy audit evaluates a farm's current operation, makes calculations of existing systems' efficiency and compares it to proposed new systems. Based on these calculations, an Agricultural Energy Management Plan (AgEMP) is explains any energy-saving measures recommended for the farm. AgEMP reports might qualify for financial assistance from various funding sources, including but not limited to federal grants, loan programs and energy tax credits.

Missouri dairy operations received energy audits and AgEMPs through the MAESTRO program. Participants of this program represent farms smaller in size than their CAFO counterparts. The savings from implementing energy-efficient retrofits reflect the costs of improvements recommended in AgEMPs and Technical Assistance reports. Table 1 indicates the amount of energy a farm used before the program, as well as average energy savings per year.

Table 1. Average energy savings per farm.

Energy type	Current usage	Average savings per farm	Savings per year	Installed cost per practice
Electricity	63,543 kWh	16,125 kWh (25%)	$481	$4,958
Propane	893 gal.	360 gal. (40%)	$883	$4,287

Energy savings were determined by analyzing energy usage data and current equipment used in individual dairy farms in Missouri. Missouri farmers reviewed energy audits and AgEMPs as part of the program. Participants could apply for grant funding to offset costs of implementing new practices. Researchers found that dairy operations had four practices with the greatest potential for saving energy: lighting, water heating, milk harvesting and milk cooling.

Lighting

Depending on the number of fixtures, switching from older incandescent lighting to linear or compact fluorescent lighting (CFL) can make a substantial difference in a farm's energy usage. According to the MAESTRO Best Practices Guide, CFLs deliver the same amount of light as incandescent bulbs but use only a quarter of the energy. Although the upfront cost of CFLs is higher, they last up to 25 times longer than incandescent bulbs, and will save money in the long run. New T8 and T5 linear fluorescent bulbs are replacing older T12s, as they use 20 percent less energy, generate less noise, provide more light per watt, have better color rendering, minimal flickering and generate less heat.

Upgrading to energy-efficient lighting is a relatively easy change to make because farmers can often do it themselves. The majority of lighting retrofits changed inefficient fixtures to CFL or linear fluorescent bulbs. Some farms replaced inefficient fixtures with new pulse-start metal-halide (PSMH) bulbs and, in one instance, LED lighting. Table 2 shows an average of the savings realized by those who participated in the MAESTRO program.

Table 2. Average lighting practice energy savings per farm.

Energy savings	Savings per year	Installed cost
1,541 kWh	$307	$178

Water heating

Compressor heat recovery (CHR) units can be one of the most cost-effective purchases a dairy farmer can make, according to the MAESTRO Best Practices Guide. When milk cools in a bulk tank or with a chiller, compressors remove heat from the milk. A CHR reuses that heat to raise water temperatures as high as 110 degrees F.

Up to 50 percent of the energy required for a water heater can be recovered from heat absorbed from milk. If farmers need to purchase a water heater, note that there is significant variance in water heaters' thermal efficiency, or the percent of energy transferred to the water. An electric water heater has a thermal efficiency of nearly 100 percent. Gas and oil water heaters have a thermal efficiency of 80 percent unless they are the condensing variety that get around 95 percent thermal efficiency.

Water heaters vary greatly in standby losses, so you should consult a dealer on the ratings of various water heaters. Tables 3 shows the average energy savings per farm broken down by type of CHR water heater.

Table 3. Average energy savings per farm.

Type of water heater	Energy savings	Dollar savings per year	Installed cost
Electric	10,076 kWh	$874	$5,269
Propane	530 gallons	$1,008	$4,267

Milk cooling

Milk cooling is usually the largest source of energy use on dairy farms. Switching from an inefficient, older reciprocation compressor to a newer scroll compressor can get energy savings of up to 41 percent, according to the MAESTRO Best Practices Guide. Scroll compressors have fewer moving parts, and their upfront price isn't much higher. When purchasing a new bulk tank, specify your preference for scroll-type compressors, which work well in cool weather and can start under any system load.

Plate coolers, also known as precoolers, consist of a set of stainless steel plates installed in the milk line before the bulk tank. Cows typically produce milk at 98 degrees F, which flows into a receiver and is pumped into the bulk tank. Well water passes through the plate cooler in one direction and absorbs heat from the warm milk being pumped through the plate cooler in the opposite direction. According to the MAESTRO Best Practices Guide, a dairy farm that produces 3 million pounds of milk per year can save about $800 annually by using a precooler. Table 4 shows energy savings realized after retrofits to milk cooling operations. These savings reflect the switch from reciprocating to scroll compressors and, in some cases, the addition of a plate cooler.

Table 4. Average energy savings for milk cooling retrofits per farm.

Energy savings	Savings per year	Installed cost
5,535 kWh	$468	$4,976

Milk harvesting

Before variable speed drive (VSD) controllers were available, dairy producers had to run pumps at a constant high speed to adequately create short intervals of high vacuum, according to the MAESTRO Best Practices Guide. VSD controllers regulate the speed of the milk vacuum pump motor. VSD measures how much vacuum the system needs and adjusts the speed of the pump motor accordingly, resulting in substantial savings because the pump and motor work only as hard as as necessary. Individual savings will depend on the pump's horsepower and the number of milkings (Table 5).

Additional benefits of VSD include a quieter working environment and a constant vacuum level. MAESTRO faculty found that many times a new motor is needed in conjunction with a VSD, as older motors with low horsepower are inadequate for the new VSD digital controllers.

Table 5. Average energy savings for milk harvest retrofits per farm.

Energy savings	Savings per year	Installed cost
6,720 kWh	$583	$6,854

Is an energy audit necessary?

Dairy producers considering an energy audit may wonder whether an audit is necessary for their operation. If the answer to any of these four questions is yes, an energy audit may be in order:

- Have you recently added equipment to the farm?
- Have there been any technological or industrial advancements that improve efficiency?
- Has your farming operation grown or expanded to include new property?
- Is there an opportunity to apply for financial assistance, such as a grant, loan or cost-share?

References

University of Missouri Dairy Resource Guide (2013). *http://dairy.missouri.edu/index.html*.

USDA Milk Production Report of 23 Selected States (2013). *http://usda01.library.cornell.edu/usda/current/MilkProd/MilkProd-09-19-2013.pdf*.

Wisconsin Energy Efficiency and Renewable Energy Resource. *http://www.uwex.edu/energy/dairy.html*

MAESTRO Best Practices Guide.

Notes

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