

EnSave



Best Practices Guide

Energy Savings Opportunities for Dairy



Welcome to EnSave's Best Practices Guide.

We have prepared this guide to help dairy producers begin the path toward energy independence.



"I was amazed by how much I could save by implementing the lighting recommendations in EnSave's energy audit report."

DAIRY PRODUCER



Inside the Guide

ENERGY EFFICIENCY AND CONSERVATION

- 4 The Energy Pyramid
- 6 Farm Energy Audits
- 7 Can Your Operation Benefit from an Energy Audit?
- 8 Tractor & Implement Maintenance
- 8 Plate Coolers
- 9 Efficient Fluorescent and LED Lighting
- 9 Preventive Maintenance
- 10 Ventilation
- 10 NEMA Premium® Motors
- 11 Milk Transfer Pump VSD
- 11 High Efficiency Compressors
- 12 VSDs for Irrigation Systems
- 12 Irrigation Pump Upgrades
- 13 Energy Star® Qualified Washers
- 13 Stock Waterers
- 14 Compressor Heat Recovery
- 14 Water Heaters
- 15 Milk Vacuum Pump VSD
- 15 Pulse Start Metal Halide Lighting

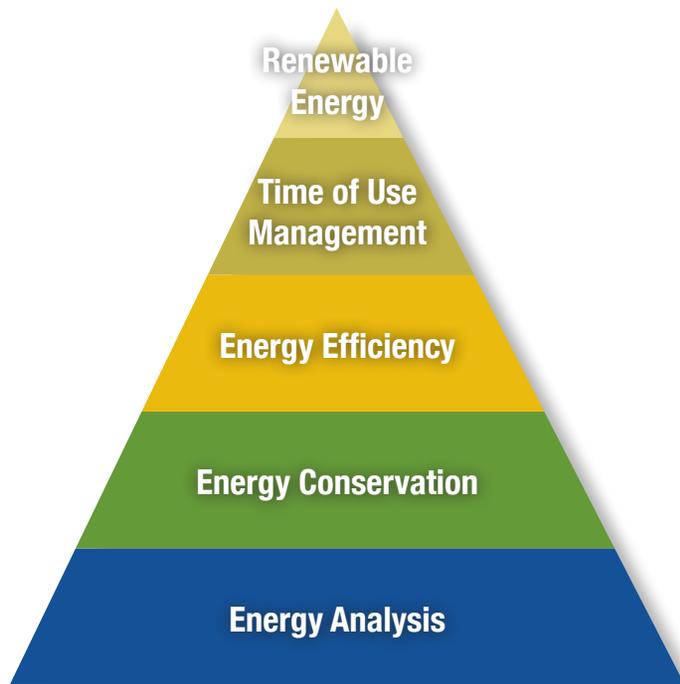
OTHER CONSIDERATIONS

- 16 Mercury
- 16 Three-Phase Power Conversion
- 17 Understanding Demand Charges and Time of Use
- 18 Renewable Energy
- 19 About EnSave

The Energy Pyramid

The energy pyramid is a useful concept designed to help people understand the process of using energy efficiently. In some cases too much emphasis is put on renewable energy to solve the nation's energy needs. Rather than being the first course of action, renewable energy should be considered only after a farm has considered all other steps of the pyramid.

The energy pyramid illustrates the steps in the process of becoming more energy independent, from the simplest and least expensive technique to the most complex.



EnSave, Inc. © 2011

Using Energy Efficiently

Farmers who are hoping to make their dairy operations more energy efficient should consider all the steps in the energy pyramid, from the simplest and least expensive technique to the most complex.

RENEWABLE ENERGY

The last step on the energy pyramid is renewable energy, which is generating your own energy from naturally replenished sources for use on the farm. Examples include solar power, wind power, methane digesters, and hydroelectricity.

TIME OF USE MANAGEMENT

Electricity costs can vary over the course of the day. Running equipment during peak hours can be costly. By running equipment during off-peak hours, money and energy can be saved.

ENERGY EFFICIENCY

The third level on the energy pyramid is energy efficiency, which is performing the same services while using less energy. Work smarter and save money with more energy efficient equipment.

ENERGY CONSERVATION

The easiest way to conserve energy is to change current behavior: turn off lights if no one is using them, unplug unused equipment, and turn the thermostat lower in the winter and higher in the summer.

ENERGY ANALYSIS

This is the very first level towards reducing energy usage. By having an audit or assessment done (or doing an assessment on your own), opportunities to reduce energy use and costs can be identified.

Throughout this brochure, you will find helpful ideas that address each step of the pyramid, from bottom to top. They are arranged according to their relevance on the pyramid, and color coded for easy reference.



Get in Touch

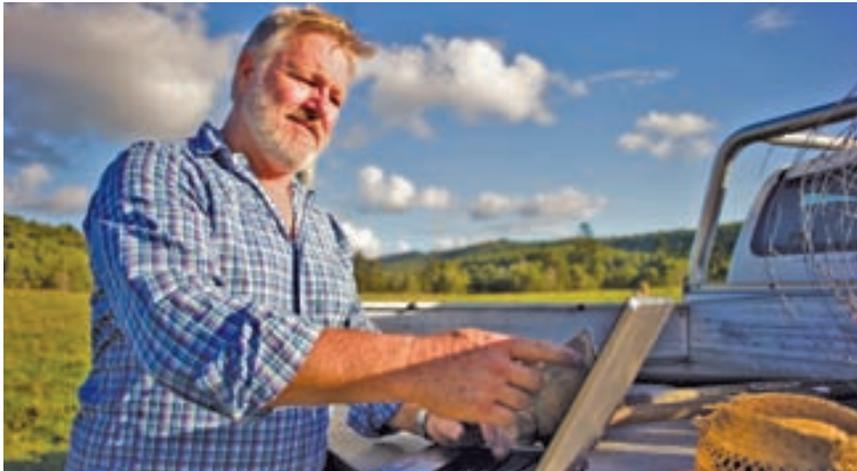
If you have any questions about the energy pyramid or would like to learn more about how these ideas can work on your operation or facility, contact EnSave, Inc. today.

65 Millet Street | Suite 105 | Richmond, Vermont 05477
www.ensave.com | (800) 732-1399

Farm Energy Audits

EnSave provides farm energy audits for producers across the United States. An energy audit analyzes current energy use and provides recommendations for energy conservation and energy efficiency. There is a tremendous opportunity on the farm to save energy and money by developing a cost-effective plan to upgrade or add energy efficient equipment.

1. We conduct an initial interview with the farmer to gather information about the operation and explain the audit process.
2. A local data collector visits the farm to verify and collect information about energy use.
3. Our energy engineers complete a thorough data analysis.
4. We deliver an audit report with energy analysis and recommendations.
5. We follow up with the farmer to answer questions, review the plan's recommendations, and discuss opportunities for implementation.



We provide several types of energy audits in order to best serve each producer, and to meet specifications required by various government cost-share programs. EnSave provides farm energy audits for all types of agriculture, including dairy, poultry, swine, greenhouses, and others. We can review electric energy savings as well as propane, natural gas, and diesel. Our farm energy audits serve as a decision-making tool producers can begin using immediately in order to take control of their energy costs.

Can Your Farm Benefit from an Energy Audit?

Complete the 7-point survey below. If your score is greater than 3, you may benefit from an energy audit. For more details or questions, call an energy expert at EnSave for a free consultation.

Dairy Questionnaire	Yes = 0	No = 1
1. Do you have a vacuum pump variable speed drive in your milking system?		
2. Do you have a plate cooler in your cooling system (used to cool the milk using ground water)?		
3. Do you have a compressor heat recovery unit or FreeHeater?		
	Yes = 1	No = 0
4. Do you have any milk cooling compressors older than five years?		
5. Are some of your circulation fans older than five years?		
6. Are there any large motors on the farm that are old and run for more than five hours per day?		
7. Would you like to upgrade to energy efficient lighting? Do you have high pressure sodium lighting, incandescent lights, mercury vapor, metal halide lamps, T12 fluorescent on the farm?		
Total Score From Both Columns		

If your score is greater than 3, you may benefit from an energy audit!





Tractor & Implement Maintenance

Regular maintenance and other practices will help tractors perform more efficiently and reduce fuel use. Consider integrating these fuel saving ideas into a regular maintenance schedule:

Gear Up/ Throttle Down

If using a high horsepower tractor while pulling lighter loads, fuel can be saved by running it in a higher gear and a lower engine speed. Be sure to stay within the engine RPM working range as specified in the operator's manual, and do not overload the engine.

- Replace air and fuel filters regularly
- Check tire pressures frequently, and replace worn tires
- Use proper ballast for each operation
- Do not idle diesel engines over 10 minutes
- Clean dirty fuel injectors
- Keep ground-engaging tools sharp
- Use the right tractor for the job (match the horsepower to the load)
- Combine trips whenever possible, by modifying equipment if necessary



Plate Coolers

In dairy operations without milk pre-cooling, milk typically comes from the cow at about 98 °F, flows into a receiver, and is then pumped into the bulk tank. Compressors then cool the milk to a storage temperature of about 38 °F.

A milk pre-cooler, or plate cooler, is a set of stainless steel plates installed in the milk line before the bulk tank. Well water passes through the plate cooler in one direction and absorbs heat from the warm milk pumped through the plate cooler in the opposite direction. Milk cooling costs account for some of the greatest energy expenses on a dairy operation. For example, a dairy farm that produces 3 million pounds of milk per year can save about \$800 annually.

Benefits of a Plate Cooler

- ✓ Extends equipment life by reducing load and run time
- ✓ Increases milk quality by inhibiting bacterial growth
- ✓ Saves electricity and money

Efficient Fluorescent and LED Lighting

Incandescent light bulbs are inefficient, converting only 10% of the energy they use to light, with the rest wasted as heat. There are many types of fluorescent lights available that are much more energy efficient.

Compact Fluorescent Lamps (CFLs) deliver the same amount of light as incandescent bulbs, but use only 1/4 of the electricity. Installing CFLs may cost a little more initially, but they can last up to 10 times longer. Cold Cathode Fluorescent Lamps (CCFLs) can last up to 25 times longer and have around the same efficiency as CFLs.

T-8 and T-5 lights with electronic ballasts replace the older T-12s and have several benefits. In addition to using about 20% less energy, the T-8 and T-5s generate less noise, more light per watt, better color rendering, minimal flickering, cooler operation, and provide electric cost savings.

Light-Emitting Diodes (LEDs) use about 15% of the energy that an equivalent incandescent light uses. LEDs last much longer than any other lighting option, with a useful life range of 40,000 to 50,000 hours. Because LEDs are a new technology, they are not usually cost effective as a replacement for all dairy lighting. LEDs are most appropriate to replace high intensity discharge lighting in exterior areas of dairies. As LED technology becomes less expensive, dairies will likely find LEDs to be a smart choice for other lighting retrofits. When considering any lighting choice for the farm, make sure the fixtures and bulbs are appropriate for a farm environment.



Low-Cost Tips

- ✓ Turn off lights when not in use
- ✓ Light work areas, not the entire building
- ✓ Use daylight when possible
- ✓ Install dimmable ballasts to control light levels
- ✓ Keep reflector shields and lenses clean

Reduce Bills

If the time is not right for an upgrade, some simple preventive maintenance can often help reduce bills in the short term, and help extend the life of the equipment.

Preventive Maintenance

Keep Equipment Clean: Remove dust, soot, and debris from equipment to allow it to work more with less effort. This extends its life and reduces energy use.

Inspect Regularly: Equipment should be checked regularly. Replace parts that are showing excessive wear before they break and cause irreparable damage.

Fix Leaks: Leaks in any fluid system waste energy and money. Regular inspection helps identify leaks and keeps your fluid systems running efficiently.



Ventilation

Heat and moisture build-up in confined areas can adversely affect the health of animals and humans. Research has shown that inadequate barn ventilation can result in a production drop of 6 to 14 pounds of milk per cow per day.

Most agricultural ventilation systems rely on exhaust fans to remove moisture build-up. A good ventilation system should provide four complete air changes in the barn per hour. Properly sized and located air inlets are necessary for an effective and efficient system. Research indicates that milk production is optimized at an ambient air temperature of about 48 °F.

Fans from different manufacturers differ markedly in air delivery and energy efficiency. When upgrading or replacing existing fans, be sure to use the most efficient fans possible.

Low-Cost Tips

- ✓ **Clean fan blades, motors and controls**
- ✓ **Lubricate pivot points of shutters and inlets**
- ✓ **Check all wiring from service entrance box to point of use**



NEMA Premium® Motors

When installing a new motor or replacing an old motor, consider using a NEMA Premium® motor. While they may cost more initially, they are often cheaper to operate in the long run.

When purchasing a new motor, take into account the length of time the motor will run, how high electric bills currently are, and the right sized motor for the job. If the motor is only running sporadically, a retrofit to a NEMA Premium® motor may not make sense. However, the longer the motor runs, the greater the potential for savings. In new installations, NEMA Premium® motors are the standard.

Premium efficiency motors are usually made to higher manufacturing standards, and stricter quality controls. **FOR MORE INFORMATION, visit: www.nema.org/gov/energy/efficiency/premium/**

Low-Cost Tips

- ✓ **Select the right size motor for the job**
- ✓ **Inspect all motors on a regular basis**
- ✓ **Clean motors regularly**
- ✓ **Replace V-type belts with notched belts**

Milk Transfer Pump VSD

Many farmers use plate coolers, which use either glycol or ground water to absorb heat from the milk before transferring it to the bulk tank. The cooler's efficiency depends on the cold water temperature and the flow rates of both the milk and the water.

Standard milk pumps can't provide a constant flow of milk into the cooler, reducing the efficiency. A variable speed drive (VSD) on the milk transfer pump produces a steady flow of milk through the plate cooler, optimizing cooling. This improved performance reduces cooling costs associated with bulk tank compressors while maintaining milk quality. Tests have shown energy savings for the milk cooling system of up to 30% when the milk pump is controlled by a VSD coupled with a plate cooler.

High Efficiency Compressors

As compressors age, they naturally lose efficiency. Also, technology is constantly improving to make compressor systems more efficient. Scroll compressors are the most efficient type of compressor for small and medium farms. The scroll compressors use dual spinning scrolls to compress refrigerant. As the scrolls spin, they create ever-smaller gas pockets and generate greater pressure. Discus compressors are the most efficient type of compressor for large operations. Both types of compressors allow for capacity modulation so that the refrigeration system can match capacity to the desired load.

Increasing the efficiency of a compressor often increases the life of the equipment as well. When purchasing scroll or discus compressors, choose models that are digitally controlled and allow for capacity modulation. A refrigeration specialist can help determine which type of compressor will be the most efficient for your application.



Low-Cost Tips

- ✓ **Conduct regular maintenance, including cleaning evaporator and condenser coils**
- ✓ **Check insulation on supply and return refrigerator lines, then re-insulate where appropriate**



Benefits of a High Efficiency Compressor

- ✓ **Saves energy and money**
- ✓ **Lasts longer than other compressors**
- ✓ **Cools consistently**



VSDs for Irrigation Systems

A variable speed drive (VSD) is an electronic device that changes the frequency of the AC power going to a motor, varying its speed. This then affects the flow and pressure of the water being pumped. VSDs are energy efficient because they regulate water flow to match demand, eliminating the need for a flow control valve at the pump station.

VSDs for well and booster pumps are not useful in all applications, and an irrigation engineer should always be consulted before installation. Situations where VSDs may be useful include:

- Booster pumps for irrigation where incoming pressure and discharge demand vary
- Dramatic varying flow rates
- Steep pump curves

Low-Cost Tips

- ✓ **Water only when necessary**
- ✓ **Move irrigation to off-peak hours to take advantage of lower time-of-use electric rates**



Irrigation Pump Upgrades

Testing irrigation pumps for pumping efficiency is a good way of learning if they are working at their optimum efficiency, and can help determine if it is time for a pump upgrade.

Pump efficiency testing measures gallons pumped per minute, total dynamic head (pumping water level and operating pressure), and input horsepower. This information determines if the pump is working efficiently, or if it is time to upgrade. Prior to upgrading, consider the following:

- Upgrade to a premium efficiency motor. It will last longer and cost less to run. Use the right size motor for the job.
- Replace/repair the pump impeller/bowl.
- Make sure the impeller and bowl are properly adjusted to ensure the proper amount of water is pumped.

Low-Cost Tips

- ✓ **Test well and pump at least every two years**
- ✓ **Inspect the well to ensure there is no clogging or corrosion**

Energy Star® Qualified Washers

Dairies do several loads of laundry a day, so there is energy savings potential from switching to an Energy Star® clothes washer. Energy Star® is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy that helps save money and protect the environment with energy efficient products.

Energy Star® qualified washers use 40% less energy than standard washers. Most full-sized Energy Star® washers use 18–25 gallons of water per load, compared to 40 gallons used by a standard machine. They also extract more water during the spin cycle, which saves energy by reducing drying time and wear and tear on fabric.



To buy an Energy Star® qualified washer, just look for the Energy Star® label or go online and review the list of qualified washers at: www.energystar.gov.

Stock Waterers

In cold climates, keeping livestock drinking water from freezing during the winter is critical. Electrically heated stock waterers have traditionally kept water from freezing, drawing 1,000 to 1,500 watts of electricity.

However, well insulated, plastic stock waterers have proven their ability to keep drinking water from freezing using 250 watts of electricity or even no electricity at all. Since the year-round ground water temperature is about 50 °F, the air temperature must fall to 20 °F to freeze solid. If enough animals drink from the waterer, the incoming water will keep it from freezing.

The unit's insulation helps to keep the heat in the water. Many units have plastic covers that float on the water and seal the opening of the reservoir when not in use. Not all sites are suitable for the energy-free models.



Did You Know?

- **Many factors determine how much water a cow drinks, including size, milk yield, feed, temperature, and water quality and availability.**
- **With low usage, the waterers must be well insulated and have reliable heaters so the floating cover will not freeze in place.**



Compressor Heat Recovery

When cooling milk in a bulk tank or with a chiller, compressors are used to remove the heat from the milk. The heat removed is usually released back into the air by condenser fans. By installing a compressor heat recovery unit, this otherwise wasted heat can be reused to heat water.

Benefits of a Compressor Heat Recovery Unit

- ✓ **Can extend life of refrigeration system**
- ✓ **Improves compressor performance**
- ✓ **Cuts water heating costs by close to 50%**

A compressor heat recovery unit can raise water temperatures as high as 110 °F. Since the incoming water is pre-heated, the water heater has less work to do and will likely last longer as a result. In addition, these units can often help improve compressor performance.

A compressor heat recovery unit can be one of the most cost effective purchases a dairy farmer can make. For example, a dairy farm using 225 gallons of heated water every day can save as much as \$1,300 on their annual electricity costs. Larger farms could see even more savings.



Water Heaters

Water heating can consume up to 20% of the energy used on a dairy farm. Having a properly sized water heater will help minimize water heating costs.

Heaters should be chosen based on how much hot water is needed over a specific period of time. On dairy farms, this is usually how many gallons per cycle are required for the milking system and bulk tank.

Use the highest Energy Factor (EF) rating for fuel type used on the operation. If gas is used, select a heater with an EF rating of 0.8 or more. If electric is used, look for an EF rating of 0.91 or more.

Low-Cost Tips

- ✓ **Inspect system and repair for leaks**
- ✓ **Insulate water heater and lines from tank**

Milk Vacuum Pump VSD

A Variable Speed Drive (VSD) is a digital controller that regulates the speed of the milking vacuum pump motor. Before variable speed technology, dairy operators had to run their pumps at a constant high speed to perform adequately during the short intervals of high vacuum need.

The VSD measures how much vacuum the system requires and regulates the speed of the pump motor. The result is a pump and motor that work only as hard as they need to, which leads to substantial energy savings.

The energy and cost savings from installing a VSD varies based on the horsepower of the pump and the number of milkings. Many operations find a VSD to be a good investment.



Benefits of a Milk Vacuum Pump VSD

- ✓ **Cuts electricity use**
- ✓ **Maintains a constant vacuum level**
- ✓ **Provides a quieter working environment**

Pulse Start Metal Halide Lighting

Pulse start metal halide lighting is an excellent choice for barn yards and other exterior areas. They are also well-suited for interior areas where linear fluorescent fixtures cannot be mounted.

Pulse start metal halide lights are long lasting with a rated life of approximately 20,000 hours. They produce more lumens per watt and have a better quality light than high pressure sodium, probe start metal halide, and mercury vapor lights.

Pulse start metal halide lights have shorter start times than other high intensity discharge lighting. Fixtures can be mounted on walls, poles, or on the ceiling. Pulse start metal halide fixtures work well with photocells and are becoming the standard for outside lighting. Significant energy savings can be realized by replacing probe start metal halide, high pressure sodium, and mercury vapor lighting with pulse start metal halide lighting. LED exterior fixtures are also becoming a cost effective exterior lighting option.





Did you know?

- **Mercury is extremely toxic to the nervous system**
- **Mercury evaporates at room temperature, making it easy to inhale**
- **Land tainted with mercury can lower its property value significantly**

Mercury

Mercury is an odorless, silvery liquid with a metallic luster. It expands and contracts with temperature and pressure changes, which makes it perfect for use in vacuum gauges (manometers). The mercury in manometers can become tainted with water, dirt, or cleaning solutions. It is also considered hazardous waste, so mercury disposal can be dangerous and even deadly if not properly managed. When possible, replace manometers containing mercury with non-mercury gauges.

An acceptable alternative is a digital gauge. It can be powered by the same source as the vacuum pump or auto-washer so it can be turned on and off with the system. Digital gauges can also make it easier to run a milking system at an efficient pressure level, thus reducing milking time and energy consumption.

Three-Phase Power Conversion

There are two main types of three-phase power converters:

1. Rotary three-phase converters are reliable, last the longest, and produce balanced three-phase power.
2. Static phase provides three-phase power long enough for a motor to start up. They can be used after the motor starts, but only at 2/3 the rated horsepower.

When using converters, ensure the voltages are balanced. Damage from overloading or overheating could result otherwise. While variable speed drives (VSDs) can be adapted to work as a three-phase power converter, it is not recommended. They are short-lived, do not produce balanced three-phase power, and can burn out equipment. They are for use with motors only, and should not be used to power multiple loads.



Understanding Demand Charges and Time of Use

Electric demand is the rate at which electricity is being used by a consumer at any given time, and is measured in kilowatts (kW). The electric utility is concerned about the peak demand because it must maintain power quality with appropriate equipment and capacity to meet this peak. The consumer's peak demand during the month is based on a moving 15-minute average for that month.

To pay for the generation and transmission capacity to meet peak demand, utilities charge their larger energy users a demand charge based on the single highest 15-minute demand period measured in a month or a specified time period.

Some utilities have different demand rates based on the time of day when the peak occurs. The higher demand rates are for periods of the day when the utility sees higher demand. Since this demand is based on when the energy is used, there may be opportunities to reduce demand charges by better managing the time period in which equipment is used. This is what EnSave refers to as "time-of-use management."

Reducing demand not only saves you money, but also helps the environment. When utilities do not need to generate as much power, they avoid needing to increase capacity through building new power plants or purchasing more energy from other suppliers.

While an energy audit explains where your energy is being used, if demand charges are a concern for your farm you may benefit from a more detailed analysis. To learn about how time of use management can help your farm save money, call EnSave at (800) 732-1399.



To reduce your electric demand, consider:

- **Moving certain operations to off-peak periods**
- **Avoiding having all equipment running at the same time**
- **Making sure your equipment is properly sized for the need**
- **Implementing electronic controls**



PHOTO COURTESY OF NRCS



Renewable Energy

It is recommended that, before pursuing a renewable technology, current operations be as energy efficient as possible.

However, once a farm has implemented all cost effective energy efficient equipment, renewable energy projects may make sense.

EnSave offers services to help you decide what your next steps should be regarding renewable energy.

For resource information on wind energy, photovoltaic, geothermal, and other renewable energy technology, call EnSave at (800) 732-1399.

Copyright © EnSave, Inc. 2012. This material may not be reproduced, distributed, transmitted, displayed, or published without the prior written consent of EnSave, Inc. Cover photo of chicks courtesy of USDA.

About EnSave

EnSave is the leading agricultural energy efficiency consulting firm in the United States. We help our clients achieve their energy efficiency goals while also helping farmers save energy and reduce their environmental impact.

The inspiration for our work is the hard working men and women on the farm, and we strive to provide solutions that strengthen the farm and provide long-term viability.

Our passion is helping American agriculture become more sustainable and profitable through energy efficiency and resource conservation.

EnSave does not represent or recommend any equipment manufacturer or dealer. Our goal is to help our clients save energy and conserve resources. Please consult a licensed professional before installing any new equipment on your farm.



If you would like information on how EnSave can work with you, please contact us at (800) 732-1399.

